Natural Sciences teachers' conceptualisation of 'Science and Society' in South African curriculum documents

KARRYN AUSTEN
9910681R
Protocol Number: 2017ECE060MR

SUPERVISOR
DR MEGAN DOIDGE

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ABSTRACT

The potential for South African science teachers to become powerful agents of transformation needs to be explored. Speaking of Fensham's (2002) term “educo-politics” Aikenhead (2010) argues that, "all science teachers are constantly engaged in ‘educo-politics'” (Aikenhead, 2010:615). In this study I attempted to uncover some of the socially critical aspects of science and society related themes.

This study investigated how science and society themes outlined in the Natural Sciences Curriculum and Assessment Policy Statement (CAPS) (Department of Basic Education [DBE], 2011) are understood and valued by teachers. The study provides an account of how science teachers under the direction of the curriculum statement conceptualise the pedagogical use, and social value, of Specific Aim 3 in their regular teaching of Grade 9 Natural Sciences. The Science-Technology-Society-Environment (STSE) currents presented by Pedretti & Nazir (2011) provided a theoretical framework from which this inquiry was conducted and structured.

This was a qualitative, small-scale study limited to 32 participants. The theoretical foundation of this study was influenced by the ideology and pedagogical frameworks which underpin science and society philosophies and movements in science education. An evaluation of the Natural Sciences CAPS (DBE, 2011) using such frameworks informed the development of the two research instruments used. A questionnaire was administered to 32 Grade 9 Natural Sciences teachers from government schools in the Johannesburg-West and Johannesburg-North districts in Gauteng. Three of the questionnaire participants were then interviewed using a semi-structured interview schedule. The participants varied in age, race demographics, distribution of home languages, professional qualifications and years of teaching experience. The schools where participants teach were varied in terms of demographics and available resources.

The study found that participants did not communicate a clear understanding of the principles which form science and society in the

Natural Sciences CAPS. Time constraints, deviation from science content and limited usefulness for science learning were commonly cited to justify limited science and society practices. Furthermore, participants regularly made statements which communicated their belief in the superiority of science in terms of its explanatory value. In this regard participants showed insensitivity to the cultural barriers students may experience when learning science.

This study has contributed to our understanding of how South African science teachers conceptualise and use science as society themes as outlined in the Grade 9 Natural Sciences CAPS. The findings of this study confirmed that the effects and consequences of the prescriptive elements and nature of the Natural Sciences CAPS (DBE, 2011) need to be critically evaluated. Although curriculum reform in South Africa was intended to empower teachers in their decision-making about what and how to teach, over-reliance on work schedules and Learning Support Materials (LSMs) results in the constriction of teacher agency (Stoffels, 2008). Such tendencies were observed in this study and hence it is suggested that this aspect of teacher agency be explored in further research.

KEY WORDS

Science and Society
Scientific literacy
Humanistic science education
Curriculum
Teachers
Science-Society-Technology
Science-Society-Technology-Environment
Socioscientific Issues

DECLARATION

I declare that this research report is my own work. It is being submitted for the degree of Master of Science in the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination in any other university.

Karryn Austen 3 April 2018

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ABBREVIATIONS AND ACRONYMS

ATP	Annual Teaching Plan
CAPS	Curriculum and Assessment Policy Statement
C2005	Curriculum 2005
DBE	Department of Basic Education
DoE	Department of Education
EE	Environmental Education
FET	Further Education and Training (Gr 10-12)
GDE	Gauteng Department of Education
GET	General Education and Training (Senior Phase Gr 7-9)
IKS	Indigenous Knowledge Systems
NCS	National Curriculum Statement
NOS	Nature of Science
NS	Natural Sciences
RNCS	Revised National Curriculum Statement
SMTs	School Management Teams
SSIs	Socioscientific Issues
STS	Science-Technology-Society
STSE	Science-Technology-Society-Environment

CHAPTER ONE

INTRODUCTION TO THE STUDY

1.1 Introduction

The aims of education should be to better the lives of individuals. Movements to address scientific literacy have driven the development of science and society themes (Lee, 2015). Mansour (2009) argues that basic science education for all students should be fundamentally understood as a tool for the development of a fully democratic and equitable society. Furthermore, in order to effectively respond to the needs of modern society Mansour contends that science, technology and society initiatives be given higher priority in science education. At the core of such ideology is the aim to increase scientific literacy and develop intellectual ability geared towards responsive and empowered citizenship (Lelliott, 2014; Mansour, 2009).

South African science education has followed similar patterns of theoretical and pedagogical development as seen in international science education (Ramsuran, 2005). Science education is vital in ensuring economic, technological, and global growth (Schulze & Lemmer, 2017). Despite educational changes aimed at redress and increased awareness about the importance of science education, it is reported that since the implementation of new curricula there has been no significant improvement in the science achievement of South African students (Spaull, 2013).

In this study I explore the ways in which the National Curriculum Statement (NCS), and specifically the Natural Sciences Curriculum and Assessment Policy Statement (CAPS) (Department of Basic Education [DBE], 2011), incorporates and communicates science and society themes and philosophy. I aim to provide an account of how Grade 9 Natural Sciences (NS) teachers make use of, and value science and society themes as outlines in the Natural Sciences CAPS (DBE, 2011).

1.2 The context of the study

Education is seen as a way of improving people's lives and reducing poverty (Mansour, 2009). With an emphasis on social transformation the new South African democratic government, under the directive of a progressive constitution, implemented a new curriculum in 1997 (Maharajh, Nkosi, & Mkhize, 2016). Since then, South Africa has struggled through several curricula reforms. However, educational standards have not significantly improved (Maharajh, et al., 2016).

1.2.1 South African science education

South African science education continues to face challenges of attracting students by connecting with student interests, and low enrolment levels remain a cause for concern (Schulze & Lemmer, 2017). Lelliott (2014) reports that research done over the last 20 years shows that South African citizens have a low level of scientific literacy. In addition, students continue to perform poorly in standardised and international benchmark tests, such as the Trends in International Mathematics and Science Study (TIMSS) (Malcolm & Doidge, 2012; Spaull, 2013). There is concern over the ability of South African science education to meet the demands of specialist labour and adequately support conditions necessary to grow the South African economy (Keetan, 2014; Spaull, 2013).

Shumba (1999) argues that there are fundamental ontological differences between indigenous belief systems and scientific frameworks. This might explain the arguably ineffective science education currently experienced in South Africa. Carter (2008) sees traditional school science as privileged truth and therefore a source of normative power. Aikenhead (2005) sees science education as requiring non-western students to engage in cultural border crossing. In my experience as a science teacher, students are at times burdened by pressure to do well in science by their parents, communities, as well as mechanisms of greater society. This pressure often has a negative influence on a student's self-worth and motivation. I share Aikenhead's lament that, "as long as academic science remains a priority in school science it will extinguish the achievement of a productive and educationally sound science experience for most students" (Aikenhead, 2010:615).

1.2.2 Curriculum reform in South Africa

For South African education the last two decades have been characterised by extensive curriculum reform and revision (Mudaly & Ismail, 2013). Curriculum policies have been informed by theoretical frameworks which are sensitive to culturally embedded knowledge (Ramsuran, 2005). Some of the frameworks include multi-cultural science education, indigenous knowledge systems, and valuing multiple ways of knowing (Mudaly & Ismail, 2013). However, the focus of these in the curricula documents has varied and the current South African science curriculum remains fundamentally orientated in a more traditional curricula conception (Ramsuran, 2005).

The Curriculum 2005 (C2005) (DoE, 1997), and the Revised National Curriculum Statement (RNCS) (DoE, 2002) placed importance on multicultural science education (Ramsuran, 2005). However, when comparing the current Natural Sciences CAPS (DBE, 2011) to the earlier curricula I noticed that science and society themes have been progressively compacted and simplified. In reviewing curriculum reform in post-apartheid South Africa, De Wet & Wolhuter (2009) argue that transformation-driven ideology is seen in educational reform when developing nations work though the typical process of democratisation. However, these authors suggest that South African transformation has been hindered by “demographic, economic, political and other realities” (De Wet & Wolhuter, 2009:363). Reform efforts are failing to fulfil the noble objectives of liberation (De Wet & Wolhuter, 2009).

1.2.3 Science education as a political entity

Science education is a political entity which significantly influences many aspects of our society (Dos Santos, 2009). Aikenhead (2003a) contends that choices made about a nation's curricula are primarily political. He speaks of the historical and continuing competition between two powerful ideologies that underpin science education. The first is inclusive and learner-centred and promotes human values with a focus on developing scientific literacy for all citizens. The second places value on training and academic screening for professional science careers (Aikenhead, 2003a). Aikenhead argues that although traditional school science is failing, the subject is still considered to have high status which enables its political objectives. He suggests that science education continues to be plagued by the "tension between educational soundness and political reality" (Aikenhead, 2003a:1). Political influences on science education, while acting to ensure the status quo, do not necessarily ensure sound educational outcomes (Aikenhead, 2003a).

Aikenhead (2005) argues that traditional science education has functioned to serve the needs of privileged western students. Ramsuran (2005) questions "homogenising, hegemonic conceptions of scientific literacy ... not only in the lists of knowledge, skills, values, contexts and language it commends, but in choices of whose knowledge it represents and why" (Ramsuran, 2005:2). Such questioning is important in order to address the inequality perpetuated by current South African science education. Aikenhead (2001) suggests that science education which is culturally sensitive to alienated, non-western science students is most beneficial.

1.2.4 Cultural and language considerations in science education

As a discipline, science has cultural baggage, especially when taught in the context of non-western, developing nations such as South Africa (Jegede & Aikenhead, 1999; Mpofu, Otulaja, & Mushayikwa, 2014). Aikenhead (1997) argues that science learning for a non-western student means negotiating a significant cultural gap. It is argued that performing well in the subject of science is simply a measure of a student’s ability to abstract efficiently within the constructs of western scientific language (Shumba, 1999).

There is an entrenched association of scientific knowledge with western culture and how language as a sociocultural framework impacts a student’s formation of scientific concepts (International Bureau of Education and the Chinese National Commission for UNESCO, 2000). For students whose first language is not English this presents an obstacle to learning in science. Furthermore it can be argued that, “although English is regarded as the language of commerce, technology, education and training, it is the home language of only 8.2% of South Africans” (De Wet & Wolhuter, 2009:364).

1.2.5 Epistemological orientations of science education

According to Aikenhead (2003a) meaningful understanding of pure traditional scientific concepts is not possible for the majority of school students. This leaves many students feeling inferior when in actual fact many of these students have incredible potential in terms of working with others, collaborating and inspiring, motivating and generating creative solutions to social problems. Aikenhead (2003a) continues his argument by reporting that meaningful learning of science is attainable for a larger number of students if it is taught in "contexts in which people are personally involved in a science-related everyday issue" (Aikenhead, 2003a:13). Often formal science education ends up making students feel inadequate and contributes to the development of powerful negative self identities (Hansen, 2008; Mpofu, et al., 2014). Research has suggested that, “if the orientation of the school curriculum does not value the local, young people are left without a solid base from which to navigate the wider world with confidence” (Nelson Mandela Foundation, 2004:14). Furthermore “in a society that needs a vast array of excellences, this could be debilitating ... [and] for children whose talents are ignored or undervalued, it could be tragic” (Noddings, 1998:52).

1.2.6 Science teachers' identity, beliefs and practice

The ways in which a teacher's identity is enacted within the classroom can be understood by the term, 'complementary curriculum' which is explained as "the embedded and often unconscious expression of one’s beliefs” (Moroye, 2009:805). In this conceptualisation of pedagogy the 'complementary curriculum' is a teacher's unique interpretation of the specified curriculum in combination with her beliefs and personal identity. Luft & Roehrig (2007) argue that understanding teachers' beliefs is vital in understanding their decisions and practice in the classroom.

It is suggested that science teacher identity is specialised because of the manner in which the subject matter affirms their personal and professional identity (Pedretti, Bencze, Hewitt, Romkey, & Jivraj, 2008). Science teachers are inducted into a scientistic way of thinking during their university training and are taught to see science as a superior explanatory framework (Aikenhead, 2003b). According to Mavhunga & Rollnick (2016) the epistemological orientation and practice of teachers is influenced by core beliefs that are formed from their earliest educational experiences. These authors found that more experienced teachers may be more resistant to change due to the core beliefs they have developed over the span of their careers. If teachers view their purpose in the class to be to provide students with scientific facts they will have "traditional and instructional beliefs" (Mavhunga & Rollnick, 2016:835). Arguably “many teachers view their role as champions, and not necessarily purveyors, of scientific knowledge” (Mueller, Tippins & Bryan, 2012:2). As a result, science teachers tend to promote scientistic notions that are underpinned by the belief in the authority of science as 'truth'. It is argued that school science has failed in part due to teachers presenting science in a 'dishonest and mythical' manner (Aikenhead, 2003b).

Moroye (2009) believes that science teachers have a significant role to play in the implementation of science and society curricula objectives. She reports that when objectives related to science and society approaches have successfully been incorporated into lessons, it has in fact been due to the skills, abilities and orientations of teachers themselves. However, adopting science and society philosophy has the potential to threaten a teacher's professional identity (Pedretti & Nazir, 2015).

Mansour (2009) claims that the realisation of science and society curriculum objectives is fundamentally dependent on the extent to which teachers are able to accommodate associated philosophical approaches within their own belief systems. Aikenhead (2003b) argues that a teacher's beliefs, values and identity affects their humanistic orientation to science teaching (Aikenhead, 2003b). Aikenhead (2003a) argues that in committing to science and society ideology, science teachers must understand and integrate multiple and diverse epistemological orientations. This necessitates the taking up of certain theoretical stances on science education.

Teachers decide how to read and understand the curriculum and also what to implement (Aikenhead, 2003b). Witz & Lee (2009) argue that teachers value their personal belief systems above the intended objectives of a new curriculum and therefore tend to implement new policies superficially while retaining underlying beliefs and old habits. Teachers' belief systems act as a filter when they make decisions about concepts and learning experiences and may cause a teacher to reject certain teaching approaches (Luft & Roehrig, 2007). This is a vital issue which initial curricula reforms and implementation initiatives in South Africa have seemed to have overlooked. It is argued that philosophical frameworks that form the foundation of science and society are not explicitly defined in the curriculum statements (Onwu & Stoffels, 2005).

This study examines teachers' beliefs and reactions to science and society in the Natural Sciences CAPS. This inquiry therefore explores the extent to which science teachers accommodate associated philosophical approaches within their own belief systems. The ways in which teachers are reading, understanding, and using science and society in the Natural Sciences CAPS can then be evaluated.

1.3 The research problem

As a South African science teacher, I feel that the Senior Phase science curriculum remains oriented towards academic preparation for further studies. I have been witness to how this orientation excludes many students from meaningful engagement with science as a subject.

I investigate how science teachers understand and utilise the science and society themes in the curriculum statement. My study focuses on Specific Aim 3 in conjunction with the preamble in the NS CAPS (DBE, 2011), which are based on themes relating to science and society. It is in teachers' conception of Specific Aim 3 and science and society themes that the battle for emphasis in the science curriculum is played out.

1.4 Aim of the study

This study aims to investigate how science and society themes outlined in the NS CAPS (DBE, 2011) are understood and valued by teachers. The study aims to provide an account of how science teachers under the direction of the curriculum statement conceptualise the pedagogical use, and social value, of Specific Aim 3 in their regular teaching of Grade 9 Natural Sciences.

The research questions are as follows:

Research Question 1:

> How do Grade 9 Natural Sciences teachers understand and value science and society themes as outlined in the Natural Sciences Curriculum and Assessment Policy Statement?

Research Question 2:

> How are Grade 9 Natural Sciences teachers' stated practices influenced by science and society themes as outlined in the Natural Sciences Curriculum and Assessment Policy Statement?

The first of these considers the presentation and historical development of Specific Aim 3, outlined in the NS CAPS (DBE, 2011). The second area of investigation incorporates science teachers' motivations, beliefs, ideas and understanding of how they conceptualise and incorporate science and society themes into their science teaching.

1.5 Delineating the study

This is a qualitative, small-scale study limited to 32 participants. The theoretical foundation of this study is influenced by the ideology and pedagogical frameworks which underpin science and society philosophies and movements in science education. An evaluation of the NS CAPS (DBE, 2011) using such frameworks informed the development of the two research instruments used. A questionnaire was administered to 32 Grade 9 Natural Sciences teachers from government schools in the Johannesburg-West and Johannesburg-North districts in Gauteng. Three of the questionnaire participants were then interviewed using a semi-structured interview schedule. The interview participants were selected based on their unique categories of teaching experience so that each would have experienced different stages of curriculum reform in South Africa. The development of the interview schedule was influenced by the findings of the questionnaire.

1.6 Importance of the study

The improvement of South African science education is a national agenda (Schulze & Lemmer, 2017). Ramsuran (2005) shows that both C2005, as well as the RNCS, advocated scientific literacy as an aim for science education. She warns that scientific literacy as promoted in these documents is informed by the specific political and economic contexts of western industrialised nations (Ramsuran, 2005).

Certain nuances relating to science and society themes have been subtly down-played in the various revisions of the NCS (Ramsuran, 2005). Ramsuran (2005) claims that this is especially true in the case of revisions made to the Natural Sciences policies, and specifically in relation to science and society philosophies and educational frameworks.

1.7 Sequence of the research report

This research report consists of five chapters. Chapter 1 provides an overview of the context and importance of the study by presenting a rationale for the study as well as the specific problems being investigated.

The theoretical framework which underpins this study is presented in the second chapter. The first part of Chapter 2 examines the characteristics of science education in the context of South Africa. The influence of various curriculum reforms as well as the beliefs and values of science teachers on student enrolments and achievement is discussed. This includes a specific examination of science and society themes in the NS CAPS (DBE, 2011). The second part of this chapter presents an overview of the development of the theoretical underpinnings of science and society pedagogy. Chapter 2 concludes with a presentation of the conceptual framework for this study. An explanation of the conceptual framework is provided.

Chapter 3 consists of an overview and justification of the research methodology employed in this study. Readers are provided with a summary of the research process and information about the instruments used. Information is also provided about the participants in this study.

Additionally, the rigour of this study is discussed and the ethical concerns are evaluated.

The results of this study are presented and discussed in Chapter 4. This chapter begins with a discussion on how the data was analysed and progresses to the identification and explanation of important themes which provide support in answering the research questions of this study.

Chapter 5 summarises the findings of this study. This final chapter includes reflection on the research process of the study. In conclusion recommendations are provided with suggestions for possible future research.

CHAPTER TWO

LITERATURE REVIEW AND THEORETICAL FRAMEWORK

2.1 Introduction

This chapter reviews the relevant literature and theoretical frameworks for the study. The philosophical and theoretical frameworks of science and society are the focus. In particular, Pedretti & Nazir's (2011) comprehensive framework for understanding science and society pedagogy is discussed. Using the typological map of the six STSE currents proposed by Pedretti & Nazir, the specifications and guidelines of the Grade 9 Natural Sciences CAPS will be evaluated and mapped. The conclusions made from the mapping of the Grade 9 NS CAPS served as a framework for the data collection and analysis of this study.

The conceptual framework that integrates important factors outlined in the chapter is considered as a starting point. Figure 1 is a representation of how key concepts are positioned and relate to one another. The format of a Venn diagram was used as this allows the intersections of important components (sets) to be depicted.

Some of the sets and intersections shown in Figure 1 have been discussed in the previous chapter. Issues contextualising curriculum reform (set F) in South African society (set E) were discussed. Sociocultural and contextual factors relating to South African science education were also highlighted as being important in exploring science and society in the Grade 9 NS CAPS (sets G and H). The significance of teachers' identities and belief systems was emphasised in order to understand how the science and society themes in the curriculum are understood and implemented (sets J, K and M).

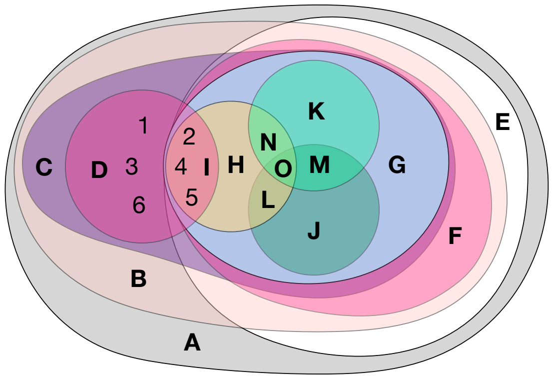


FIGURE 1 KEY	
A	Global society
B	Global Science education
C	Global science and society education
D	STSE Currents (currents 1 - 6)
E	South African society
F	South African science education
G	SA science and society education
H	NS CAPS
I	STSE Currents that appear in NS CAPS (currents 2, 4, 5)
J	Teacher beliefs, values and identity
K	Teacher practices
L	Influence of South African society on NS CAPS
M	Influence of teacher beliefs, values and identity on practices
N	Influence of NS CAPS on teacher practices
O	STUDY FOCUS: Intersection of G, I and J

Figure 1: A conceptual framework showing the dynamics of science and society education in South Africa

2.2 Science education in the global context

(Figure 1: sets A and B)

Developed economies necessitate a scientifically literate population to support political, economic, technological and information mechanisms (Hansen 2008). It is argued that science education is dynamically inter-connected with greater social, political and environmental systems (Bencze, 2010). Our modern technological societies tend to view the success of a nation’s science education as being related to its prospect for economic growth and prosperity (Hansen, 2008). As the importance of democratic citizenship has become more acute, debates supporting the development of a scientifically literate citizenry have become a focus in junior science curricula around the world (Lee, 2015). Debates about the goals of science education show tension between providing science education to prepare scientifically literate citizens and science education that ensures adequate technical and conceptual preparation for further specialist studies in science (Aikenhead, 2003a; Lee, 2015).

Aikenhead (2007) speaks of the fundamental 'pluralism' of science. The diversity in the aims of science education is demonstrated in the debates which argue that science education should both prepare scientifically literate citizens and at the same time lay foundations of scientific conceptual understanding such that students can continue with further science-related studies (Aikenhead, 2003a). Those opposing a technically dense, conceptually traditional science curriculum call for a more humanistic science curriculum which promotes the holistic development of scientifically literate students (Aikenhead, 2003a; 2003b).

It is argued that traditional school science curricula are "derived from highly abstract and fragmented statements of Western canonical knowledge" (Carter, 2008:166). As a result, traditional science education tends to exclude all but a small group of students who possess the required social and cultural capital to succeed in this academic context (Aikenhead, 2005; International Bureau of Education and the Chinese National Commission for UNESCO, 2000).

2.3 Science and society education

(Figure 1: set C)

Science and society pedagogical strategies focus on scientific and technological developments from within cultural, economic, social and political contexts (Mansour, 2009). Students are required to make informed decisions about science, society and technological issues.

2.3.1 Root concepts

The term 'scientific literacy' can be summarised as "the science learning that is of most worth" (Ramsuran, 2005:2). Scientific literacy is best understood by evaluating the specific context or situation in which that knowledge is created and used (Sammel, 2014). Experiencing peaks and troughs in popularity, the use of the term 'scientific literacy' is not a new phenomenon in science education and research (Holbrook & Rannikmae, 2009). Traditional school science has undergone various reforms since the early 1900s and movements which provide divergent approaches have been underpinned by the notion of science as a 'human endeavour' (Aikenhead, 2003a). In this alternative approach to science education emphasis is given to the needs and interests of the students (Holbrook & Rannikmae, 2007). This approach envisages students as citizens and technology consumers (Aikenhead, 2003a). This framework is in opposition to the view of science education as important solely for the preparation of students for specialist science careers (Aikenhead, 2003a). Such ideological developments are important in addressing concerns over decreasing enrolment numbers in science and creating more interest for students in the subject (Mansour, 2009).

However, unraveling the meaning of scientific literacy is problematic. Scientific literacy is understood in relation to the needs of a certain population being able to function equitably and optimally within their societies as democratic citizens (De Boer, 2000). This presents a challenge for the South African context because definitions are fundamentally embedded in the western world view of science and science education (Aikenhead, 2007; Hurd, 1997).

More recently frameworks for teaching scientific literacy have paid attention to the character and social development of students (Zeidler, Sadler, Simmons, & Howes, 2005). Zeidler & Nichols (2009) argue that in supporting the development of scientific literacy a greater collective conscience is fostered which ultimately instils in students the need to behave consistently with integrity and self regulation though internal evaluation. This orientation to science teaching promotes values such as "reliability, trustworthiness, dependability, altruism, and compassion" (Zeidler & Nichols, 2009:54).

According to Aikenhead (2003a) a humanistic approach to science education was developed due to two factors. The first of these is the recognition that science education is enmeshed in cultural aspects of society. The second catalyst for humanistic science education is argued to be dissatisfaction with traditional science education (Aikenhead, 2003a). Disillusionment includes concerns about decreasing enrolment numbers of science students and the lack of interest in the subject. Aikenhead (2003a) highlights that paradoxically a dilemma is produced when the failure of school science undermines its primary goal of adequately preparing enough students for specialist careers in science. He believes that more humanistic approaches to science education will help address some of these issues.

2.3.2 Branches and pedagogical movements

Aikenhead (2005) points out there is little consensus about the term Science-Technology-Society (STS) which has many different pedagogical and curricula enactments. We first see themes in Environmental Education (EE) directives which emerged from earlier activist campaigns concerned with the natural environment (Pedretti & Nazir, 2011). The Science-Technology-Society (STS) movement was founded to explore the role that technology plays in these issues (Aikenhead, 2005).

2.3.3 Features of STS science teaching

Aikenhead (1994) contends that the purpose of STS teaching is to orientate science from a student's perspective. In order to do this, the integration of three domains (science, technology and society) is necessary. These domains are represented by the three blocks in Figure 2. Aikenhead gives explanations of each of these domains by providing phrases which describe how a student would experience each domain. The student as a central point in Figure 2 is linked to each domain by solid arrows. Pedagogy that would assist the student in integrating the three domains is shown by broken-line arrows.

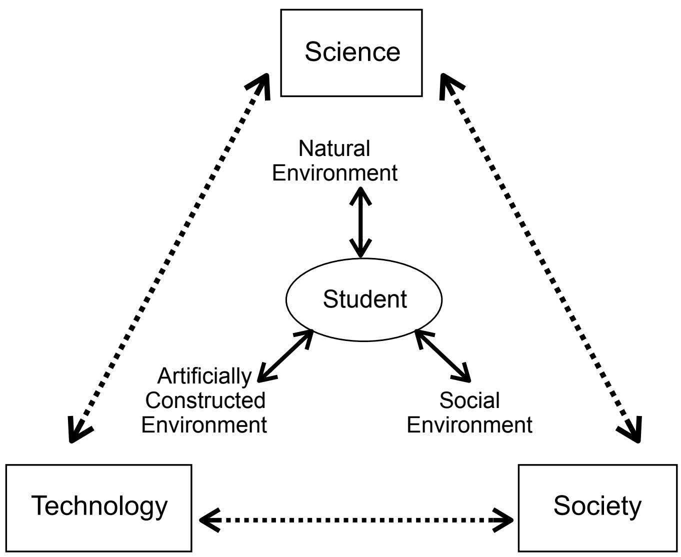


Figure 2: The essence of STS education (Aikenhead, 1994:48)

Aikenhead (1994) explains how different curricular perspectives and learning programmes have made use of STS teaching. Based on what he terms 'categories of STS Science', Aikenhead proposed a spectrum to explain how STS themes can be incorporated into traditional science teaching. The spectrum includes eight categories which range from emphasis on science and society themes to emphasis on traditional science content. Aikenhead found that the majority of approaches are located in the middle sections of the spectrum where science and society themes are more equally integrated with traditional science content than at the extremes of the spectrum.

The way Aikenhead conceptualises the sequence of teaching when STS content is shown in Figure 3.

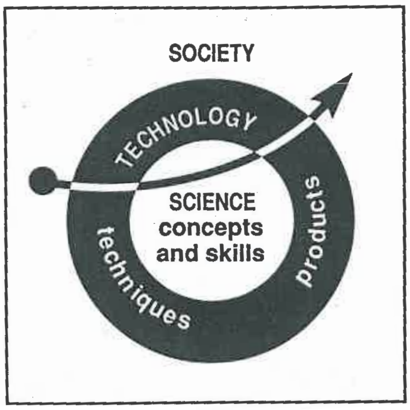


Figure 3: The sequence for STS science teaching (Aikenhead, 1994:57)

In Figure 3 an arrow delineates the sequence of STS teaching. The arrow begins in the domain of society. Aikenhead explains that STS lessons should begin by posing a social problem or question to the students. In order to address this problem or question, students would need to explore the technology which relates to the particular issue. Hence the arrow moves through the technology domain. In order to understand the technology underpinning the problem, students grapple with the traditional science which informs the technology. This is shown by the arrow denoting scientific principles moving through the inner circle in Figure 3. Once the students have explored the scientific principles involved, they return to the technology with a deeper understanding. They finally revisit the original social problem or question. This is shown when the arrow in Figure 4 returns to the domain of society. The process ends with students making an informed decision about the problem.

Zeidler et al. (2005) argue that Science-Technology-Society-Environment (STSE) education benefited the STS movement in that STSE initiatives aimed to increase issues-based contexts. As such, STSE education is able to identify controversial phenomena.

2.3.4 The gains of STS science teaching

Bennett, Lubben, & Hogarth (2007) conducted an in-depth systematic review of 17 studies that reported on the effects of science and society teaching. They found that STS approaches to teaching can be beneficial. STS teaching results in students having a more positive attitude to science and scientific concepts. Improved attitudes took place across gender differences. The authors, however, found that students taught using an STS approach compared to a traditional approach understood scientific concepts at a similar level. These findings are also supported by Yager, Yager, & Lim's (2006) research.

Further findings by Yager et al. (2006) indicated that STS approaches resulted in students being able to make use of scientific concepts in new contexts and these students were able to propose unique and complex uses of scientific concepts. The frequency and quality of students' questions was also observed.

A further benefit of using STS approaches in science teaching is the opportunity for students to nurture their emotional intelligence and develop character and understanding of human value (Zeidler & Nichols, 2009). Zeidler & Nichols also reported that STS teaching facilitates the development of critical thinking.

It is argued that critical evaluation of science education is important as traditional approaches continue to "alienate a large section of students, especially minorities and people of non-Western cultures" (Pedretti & Nazir, 2011:615). In this way a science and society approach in the South African context could be invaluable.

2.4 The Six STSE Currents of Pedretti and Nazir

(Figure 1: set D)

Pedretti & Nazir (2011) report on the diverse and multi-dimensional aspects which have been part of the science education reform dialogue for the past four decades. In telling the story of the development of Science-Technology-Society-Environment (STSE) education, Pedretti & Nazir provide explanations for the diverse and varied pedagogical approaches which have developed within the STSE movement as a whole. These authors argue that it is because of these different approaches that the STSE slogan is sometimes seen as confusing (Pedretti & Nazir, 2011). They offer teachers and researchers a conceptualisation of the STSE movement and provide descriptions of what teaching aligned to STSE objectives might entail. Pedretti & Nazir present a map of the different STSE approaches. They suggest that teachers can use this as a tool when making decisions about how to incorporate STSE. The metaphoric use of the term currents communicates the authors' view of, "STSE education as a vast ocean of ideas, principles, and practices that overlap and intermingle one into the other" (Pedretti & Nazir, 2011:602).

Figure 4 summarises the six currents. The sequence in which these currents emerged in science education loosely informs the numbering of each current. The more traditionally oriented approaches are situated within the first three currents. In applying the four description criteria, characteristics of each of the STSE currents emerge.

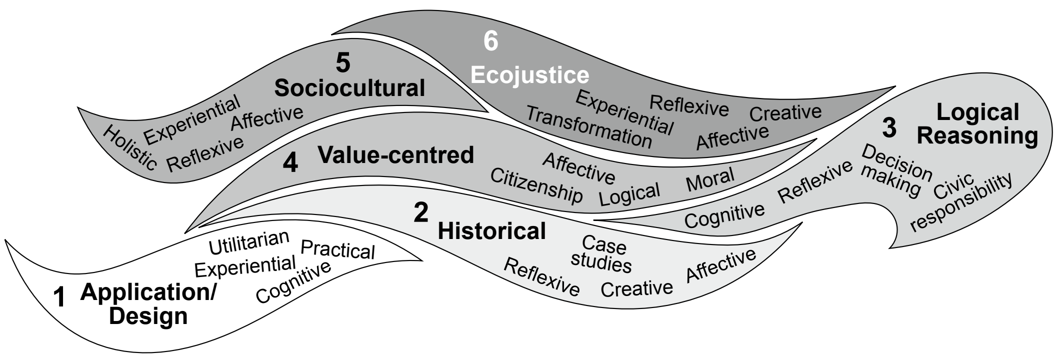


Figure 4: Representation of STSE currents
(adapted from Pedretti & Nazir, 2011:607-608)

Using an extensive coding process, Pedretti & Nazir (2011) propose four criteria to explore each of the STSE currents identified from science and society education research and programmes. These four criteria are focus (specific characteristics of the current), aims of science education (how the current conceptualises scientific literacy), dominant approaches, (the educational focus of the current), and teaching strategies (practical pedagogy to assist in teaching the current) (Pedretti & Nazir, 2011). Each current holds its own set of criticisms as well as documented advantages.

Steele (2013) argues that Pedretti & Nazir's (2011) STSE currents help to explain the varying ways in which teachers can incorporate the objectives of science and society in their teaching. She makes use of the STSE currents taxonomy in her study of high school science teachers in under-resourced, rural communities in Ontario. She refers to the currents as a "coherent and comprehensive framework" (Steele, 2013:20) in which Pedretti & Nazi have managed to map out many different approaches to STSE education in a systematic way. Steele's study focused on the classroom practices of teachers with reference to how they made use of resources and did not include aspects of curriculum conceptualisation by teachers. However, I felt that the STSE currents could offer the same systematic framework for this study.

2.4.1 The Application and Design Current

Pedretti & Nazir (2011) explain that this current emphasises the relationship between science and technology. Students are encouraged to be creative in designing and testing new or modified technology with a focus on utilitarian problem-solving. A common approach to using this current is the making of a technological design project. This current requires students to engage in higher order thinking in combination with practical experimentation that allows opportunity for the application of scientific concepts (Pedretti & Nazir, 2011).

2.4.2 The Historical Current

This current emphasises the idea that science is fundamentally a human construct (Pedretti & Nazir, 2011). Students are encouraged to understand how scientific ideas are necessarily embedded in historical and socio-cultural contexts. With the aim of increasing student interest, as well as fostering an appreciation for science as a subject, the teacher will make use of approaches that elicit creative and emotional responses from students (Pedretti & Nazir, 2011). Exploring historical case studies is argued to support students to see themselves as democratic citizens and therefore contributes to this aspect of the development off scientific literacy (Pedretti & Nazir, 2011).

2.4.3 The Logical Reasoning Current

This current involves the use of contentious socioscientific issues (SSIs). Students are required to employ positivist logical reasoning in order to deliberate about the science related to a social issue and practice decision-making skills in reaching a potential solution (Pedretti & Nazir, 2011).

Zeidler & Nichols (2009) a that the use of SSIs implies moving beyond the STS approach to science and society teaching. They argue that STS education emphasises the relationship between science, society and technology. This includes fostering the development of a student's character, cognitive strategies and morality.

2.4.4 The Value-Centred Current

Pedretti & Nazir (2011) report that this current addresses a distinct gap in STSE approaches that emphasises ethical issues related to socioscientific issues (SSIs). This current makes students aware of the value-laden nature of science and therefore has the potential to present the true nature of science to students. Using moral reasoning characteristic approaches "tend to target students' moral and emotional identities to stimulate cognitive and moral development" (Pedretti & Nazir, 2011:612). Zeidler & Nichols (2009) contend that the development of students' values and emotional intelligence are central aspects of science and society pedagogical approaches.

2.4.5 The Sociocultural Current

Situated from a sociological orientation this current emphasises the idea that science and technology are political, cultural and social entities (Pedretti & Nazir, 2011). When using this current the teacher aims to present the students with the idea that science is only one of the many ways of knowing about the world (Pedretti & Nazir, 2011). Research shows that the use of this current allows greater accessibility to learning science for a larger group a students than traditional science teaching methods and topics (Pedretti & Nazir, 2011). It is argued that sociocultural approaches have the potential to "address the inequitable treatment of alternative knowledge systems and arrest the continuing erosion of non-Western cultures" (Pedretti & Nazir, 2011:616). Criticism of this current is based on the argument that traditional science knowledge and indigenous knowledge systems are not philosophically compatible and therefore integration of science with different knowledge systems is not possible (Pedretti & Nazir, 2011). It is argued that sociocultural issues are complex and that including this additional expectation can be overwhelming for students (Pedretti & Nazir, 2011). Despite these challenges it is important that students are exposed to local indigenous knowledge and that Traditional Knowledge Systems be presented as equally valuable ways of knowing about the natural world (Ogunniyi, 2004).

2.4.6 The Socio-Ecojustice Current

This current developed from the sociocultural current with additional emphasis on actions that could be taken to solve socioscientific issues (SSIs) and other challenges highlighted by the sociocultural current (Pedretti & Nazir, 2011). The socio-ecojustice current positions teachers and students as social activists who have the potential to transform society (Pedretti & Nazir, 2011). According to this current, science education should aim to develop the civic responsibility and democratic citizenship of students in which social equity and agency are the focus (Pedretti & Nazir, 2011). A benefit of using this current is that it elicits student interest and motivation and increases accessibility to science learning (Pedretti & Nazir, 2011).

Teachers will tend to make use of different currents for different learning situations and intended outcomes (Pedretti & Nazir, 2011). Pedretti & Nazir show that science teachers find the implementation of STSE associated pedagogy difficult on ideological and practical levels, although the authors acknowledge that teachers are supportive of the movement in general.

Criticisms which have been raised with respect to science and society approaches to science education include the concern that such teaching would result in the watering-down of scientific concepts as well as the justifiable argument that the high-minded expectations of STS education are not realistic. De Boer (2000) argues that in reality many socioscientific issues are complicated in terms of both the science involved as well as the socio-political aspects. Zeidler, et al. (2005) believe that STSE approaches fail to meaningfully make use of argumentation and discourse about the issues being considered. Although these ideas should be considered, I feel that perhaps there are grounds to disagree.

2.5 The Grade 7-9 Natural Sciences CAPS

(Figure 1: set G)

The following provides an outline to the NS CAPS in order to provide the context for the evaluation of science and society themes in the document. Changes to science and society references in previous curricula are highlighted and the impact of curriculum revisions on teachers is also explored.

2.5.1 General structure of the NS CAPS

The Grade 7-9 NS CAPS consists of four sections. The first section provides an introduction to the CAPS in general for all subjects and grades (DBE, 2011:3-7). This includes an outline of the general aims of the South African Curriculum. The ideology of the South African constitution frames the statements in Section 1 (Solomons & Fataar, 2011).

Section 2 is titled 'Introduction to Natural Sciences' (DBE, 2011:8-13). This section contains the preamble that relate to the characteristics of, and expectations for teaching Natural Sciences in South Africa. Additionally Section 2 explains how the subject is structured.

The NS CAPS is structured around four Knowledge Strands and three Specific Aims (DBE, 2011). The Knowledge Strands[1] help outline four

[1] The Four Knowledge Strands: Life and Living; Matter and Materials; Energy and Change; Planet Earth and Beyond

different disciplinary groups of subjects which constitute Natural Sciences. The Specific Aims listed below provide aims for the Natural Sciences subject as a whole.

The NS CAPS outlines three Specific Aims:

Specific Aim 1: <u>Doing science</u>

Learners should be able to complete investigations, analyse problems and use practical processes and skills in evaluating solutions.

Specific Aim 2: <u>Knowing the subject content and making connections</u>

Learners should have a grasp of scientific, technological and environmental knowledge and be able to apply it in new contexts.

Specific Aim 3: <u>Understanding the uses of science</u>

Learners should understand the uses of natural sciences and indigenous knowledge in society and the environment.

(DBE, 2011:10)

These Specific Aims are required to be incorporated across the Knowledge Strands.

Section 3 is a detailed outline of the content for Natural Sciences (DBE, 2011:17-84). Each term is allocated to one of the four Knowledge Strands for each grade. This outline also provides suggestions for tasks or investigations that relate to the topic being covered (DBE, 2011).

The last section in the Grade 7-9 NS CAPS relates to the assessment of the subject (DBE, 2011:85-93). Section 2 and Section 3 of the NS CAPS are the focus of this study when evaluating the science and society themes it contains.

2.5.2 Implementation

Curriculum reform is accompanied by new and different dialogues and ideas about education (Nakabugo & Sieborger, 2001). Revisions marked for implementation have been informed by theoretical paradigms which require practicing teachers to re-interpret and re-define their roles in the classroom (Carl, 2005; Lelliott et al., 2009). Such a drastic shift in ideology (as embodied by these reformed curriculum and educational policies) without adequate training and development of theoretical understanding, is not easily communicated through written text (Harley & Wedekind, 2004). Readings of revised curricula materials are limited by a lack of common language and theoretical understanding between teachers and policy writers (Mpofu, et al., 2014; Onwu & Stoffels, 2005).

Cycles of curriculum revisions have put added pressures on teachers as they work to come to terms with new expectations and processes (Carl, 2005). Carl (2005) points out that the role of science teachers in the curriculum design and implementation process has been relatively limited. He argues that teachers tend to take an overly passive role when negotiating curriculum change. This is due to general perceptions of the curriculum as an entity which is developed by someone in authority and which they need simply implement. This has had a significant effect on teachers ability and willingness to implement curriculum changes in their classrooms (Carl, 2005).

2.5.3 The development of the NS CAPS

Speaking of C2005, the first curriculum implemented, Lelliott (2014) explains that it was radically different from what teachers were accustomed to. There was no specific content provided and instead "provided a series of critical and specific outcomes, underpinned by the South African Constitution and based on national needs" (Lelliott, 2014:313). The outcomes were presented as objectives to be achieved by students and teachers were encouraged to utilise content and methods that would be relevant to, and support the needs of their local contexts (Nakabugo & Sieborger, 2001; Stoffels, 2007). Calls for revision of C2005 were based on difficulties teachers experienced in implementing a curriculum that did not specify content (Stoffels, 2007). As a result the RNCS was instated and this revision included descriptions of minimum core knowledge for students to acquire in certain grades (Stoffels, 2007).

Ramsuran (2005) shows that scientific literacy is defined differently in C2005 and the RNCS. She argues that C2005 had a more inclusive notion of scientific literacy that attempts to localise the definition. This is in contrast to the RNCS that shows a "strong allegiance to a universal notion of scientific literacy" (Ramsuran, 2005:10). Ramsuran contends that revisions of C2005 shown in the RNCS are appropriate for the societies of developed nations at the time, rather than incorporating local contexts and local needs into a definition.

The RNCS was replaced by CAPS which, in contrast to both C2005 and the RNCS, was not outcomes based (Lelliott, 2014). CAPS is extremely specific in the content it provides and topics are presented in detail in a week by week work schedule (Lelliott, 2014).

Lelliott (2014) in his comparison of the RNCS and CAPS, reaches a similar conclusion to Ramsuran (2005) in her comparison of C2005 and the RNCS. The limited view of scientific literacy presented in the CAPS curriculum documents is problematic as this de-contextualises science learning, making it not relevant to the lives of South African citizens (Lelliott, 2014). Combining the reports of Lelliott (2014) and Ramsuran (2005), it can be argued that each stage of revision has resulted in a different conceptualisation of scientific literacy. Furthermore, that each revision has positioned scientific literacy closer to the universal, western definition. It is interesting to note that the term scientific literacy is not mention anywhere in the NS CAPS which is perhaps an indication of the shift in focus of the curriculum developers.

2.6 Science and society themes in the Grade 7-9 NS CAPS (Figure 1: set H)

The six STSE currents proposed by Pedretti & Nazir (2011) can be applied to evaluate the science and society themes and content in the NS CAPS. However, an analysis of the NS CAPS reveals that not all of the six currents are represented. Figure 5 below shows that the historical, value-centred and sociocultural currents can be identified in the NS CAPS (DBE, 2011). The following discussion provides evidence for this.

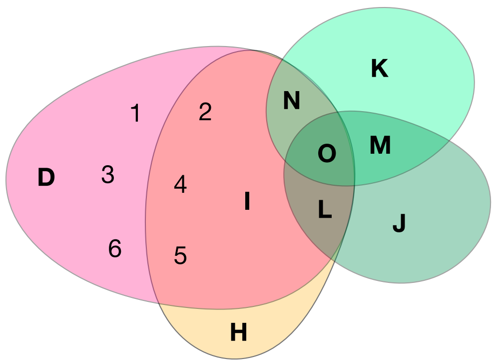


FIGURE 5 KEY	
D	STSE Currents (currents 1 - 6)
1	Application and Design
2	Historical
3	Logical Reasoning
4	Value-Centred
5	Socio-cultural
6	Socio-Ecojustice
H	NS CAPS
I	STSE Currents that appear in NS CAPS (currents 2, 4, 5)
J	Teacher beliefs, values and identity
K	Teacher practices
L	Influence of South African society on NS CAPS
M	Influence of teacher beliefs, values and identity on practices
N	Influence of NS CAPS on teacher practices
O	STUDY FOCUS: Intersection of H, J and K

Figure 5: A conceptual framework showing how science and society themes in the NS CAPS will be evaluated (sub-section of Figure 1)

Figure 5 is a sub-section of Figure 1 and shows the conceptual focus of this study that evaluates how teachers are conceptualising and using science and society themes in the Grade 9 NS CAPS.

2.6.1 Preamble to the NS CAPS

The preamble to the NS CAPS are an introduction to the subject of Natural Sciences. This section begins with the promotion of science as having diverse cultural origins. Science is described as being "part of the cultural heritage of all nations" using the justification that, 'in all cultures and in all times people have wanted to understand how the physical world works and have needed explanations that satisfy them" (DBE, 2011:8).

The preamble includes a discussion titled 'what is science?'. Science is explained to be a "systematic way of looking for explanations and connecting the ideas we have" (DBE, 2011:8). The method of scientific inquiry is explained as the replicable process of creating and testing of a hypothesis using practical and repeated experiments with a reference to determining validity of the results obtained.

In the same discussion emphasis is given to African Indigenous Knowledge Systems, with the position that past indigenous generations practiced scientific skills through “observations” and that traditional African societies “recognized regular patterns in seasons, the life cycles of plants, and the behaviour of animals” (DBE, 2011:8). Such notions can be related to how science and society themes were birthed in the need for understanding of multi-cultural science education and in efforts to make science more accessible to non-western science students (Jegede & Aikenhead, 1999). This speaks to the sociocultural current proposed by Pedretti & Nazir (2011).

There is a further section in the introduction titled 'Teaching Natural Sciences' (DBE, 2011:8-9). The following shows the content of this section.

Careful selection of content, and use of a variety of approaches to teaching and learning Science, should promote understanding of:

- Science as a discipline that sustains enjoyment and curiosity about the world and natural phenomena
- the history of Science and the relationship between Natural Sciences and other subjects
- the different cultural contexts in which indigenous knowledge systems have developed
- the contribution of Science to social justice and societal development
- the need for using scientific knowledge responsibly in the interest of ourselves, of society and the environment
- the practical and ethical consequences of decisions based on Science

(DBE, 2011:8-9)

There is a hint at the notion of scientific literacy in the phrases that science" prepares learners for active participation in a democratic society that values human rights and promotes responsibility towards the environment ... [and] can also prepare learners for economic activity and self-expression" (DBE, 2011:9).

2.6.2 Specific Aim 3

Although science and society themes are explored in all three Specific Aims to some extent, such themes are concentrated within the definition of Specific Aim 3. The idea of educating scientifically literate citizens is a direct derivative of science and society based science education, and as such would relate most significantly to the Specific Aim 3.

Specific Aim 3 prescribes that, “learners should understand the uses of natural sciences and indigenous knowledge in society and the environment”, and that, “science learnt at school should produce learners who understand that school science can be relevant to everyday life” as well as developing, “an appreciation of the history of scientific discoveries, and their relationship to indigenous knowledge and different world views [which] enriches our understanding of the connections between Science and Society” (DBE, 2011:10).

2.6.3 Evidence of science and society in the work schedule

There is a distinct lack of science and society related task and topic specification in the work schedule section of the NS CAPS (DBE, 2011). This has significant implications for how Specific Aim 3 is conceptualised and utilized by science teachers. Holbrook & Rannikmae (2007) argue that teachers need clarity about what the goals of science education are in order to meet the needs of greater society. The nature of science education is currently being poorly expressed in relation to these overall goals (Onwu & Stoffels, 2005).

Table 1 below shows a summary of the currents found in the work schedule section of the NS CAPS.

Grade 9 NS CAPS Statement	Current	Strand	pg
Researching and writing about the history of the discovery of the light and electron microscopes	Historical (2)	Life and Living	57
Researching, discussing and writing about stem cell research and ethical issues involved	Value-centred (4)	Life and Living	57
Producing a poster advocating healthy life style choices	Sociocultural (5)	Life and Living	59

Grade 9 NS CAPS Statement	Current	Strand	pg
Researching and writing about the effects of alcohol, smoking and drug abuse on the foetus [Relate this to the role of the placenta]	Value-centred (4), Sociocultural (5)	Life and Living	59
Debating and discussing issues such as abortion, infertility, surrogacy, contraception, population control	Value-centred (4), Sociocultural (5)	Life and Living	59
Researching and writing about one of the causes of health issues (such as smoking, drinking alcohol, high cholesterol levels) associated with the circulatory and respiratory systems	Value-centred (4), Sociocultural (5)	Life and Living	61
Discussing a variety of unhealthy dietary components such as additives, and the harmful effects of some diets such as eating too much fast food and diets developed for weight loss	Value-centred (4), Sociocultural (5)	Life and Living	62
Comparing balanced diets from different cultures such as kosher / halaal and non-kosher / non-halaal food	Sociocultural (5)	Life and Living	62
Reading about the causes and consequences of acid rain and including possible ways to reduce acid rain	Sociocultural (5)	Matter and Materials	68
Reading about careers in the chemical industry, including agriculture, pharmacy, chemical engineering, mining [not for assessment purposes]	Sociocultural (5)	Matter and Materials	69
Researching about alternative sources of energy that can be used to drive generators for the national grid. Compare them in terms of sustainability and environmental impact	Sociocultural (5)	Energy and Change	75
Discussing the many careers in the energy sector, including electricians, electrical engineers, artisans, IT specialists for maintaining and improving the power grid	Sociocultural (5)	Energy and Change	76
Researching and writing about a mining activity in South Africa. Describe the: - elements and compounds being mined - chemical and physical separation methods used - environmental impacts	Sociocultural (5)	Planet Earth and Beyond	80

Table 1: Representation of the Historical, Value-centred and Sociocultural currents in the Grade 9 NS CAPS (DBE, 2011)

The above discussion shows that the majority of the science and society themes evident in the NS CAPS appear in the preamble section and not in the work schedule. Only three of the STSE currents can be significantly identified in the work schedule.

2.7 Conclusion

This chapter outlined the important theory and policy which explains science and society teaching. Contextual factors of South African science education were also considered. The culmination of this chapter was an analysis of the NS CAPS using the six STSE currents proposed by Pedretti & Nazir (2011). This analysis will be used in the next chapter that discusses the methodology of this study.

CHAPTER THREE

RESEARCH METHODS

3.1 Introduction

The aim of this study was to explore the ways in which Grade 9 Natural Sciences teachers have conceptualised understanding and practice of science and society concepts in the NS CAPS.

This chapter describes the research framework within which the study took place and the process by which data was collected and analysed qualitatively and inductively. The six STSE currents of Pedretti & Nazir (2011) informed analysis and procedures put in place to ensure rigour in the research and as well as ethical standards.

3.2 Research approach

This exploration fundamentally operated from a qualitative and inductive framework and was furthermore informed by a phenomenological understanding. The data was collected using a questionnaire and an interview schedule. Both these instruments were used to analyse the NS CAPS (DBE, 2011) and explore the common ideas of the research questions of this study.

3.2.1 Research Orientation

This inquiry was situated predominantly from within an interpretivist research paradigm, although aspects of critical research processes were also included. As interpretivist research is best supported by qualitatively based data (Bhattacherjee, 2012:35) my research aimed to utilize the collection and analysis of qualitative information which is argued "to understand phenomena in context-specific settings" (Golafshani, 2003:600).

Aspects of the methodological paradigm of phenomenology were incorporated. Phenomenology originates in "accessing and subsequently understanding phenomenon ... through descriptions of it, in the person's own words" (Probert, 2006:3). This study is inductive in nature and uses a qualitative research approach.

3.2.2 Research Process

Data was collected from a sample of Grade 9 Natural Sciences teachers from three different Johannesburg districts. In the first phase of data collection a questionnaire was administered to teachers at district meetings in the three selected districts. The questionnaire was structured according to an initial analysis and coding of the NS CAPS from within the framework of the STSE currents (Pedretti & Nazir, 2011).

Analysis and coding of the questionnaire responses was done in accordance with the initial coding process. Further patterns and categories were then identified at this stage and reworked into the interview schedule. Selected and willing participants were asked to be interviewed in the second phase of data collection. Interviews conducted were audiotaped and then transcribed. Once the interviews were transcribed categories and codes were identified and applied for further analysis and commentary.

The formulation of a conceptual framework provided the starting point for analysis of the data. The critical analysis which combined the structure provided by the proposed STSE currents (Pedretti & Nazir, 2011) with an analysis of the Grade 9 NS CAPS (DBE, 2011) revealed a manner in which to view the science and society themes of Specific Aim 3. In this synthesis, allowance was made for the variances in how teachers are inclined to choose certain teaching strategies within the band of science and society approaches. Participants' choices in this regard (as framed by the STSE currents) were mapped onto the three currents identified in the NS CAPS. However, due to the ways in which these ideas were presented in the curriculum statement the degree to which teachers are required to interact with these approaches is not explicitly outlined and hence limited teachers' consideration for inclusion or emphasis.

Figure 6 below summarises the steps taken in the construction of instruments and collection and analysis of data.

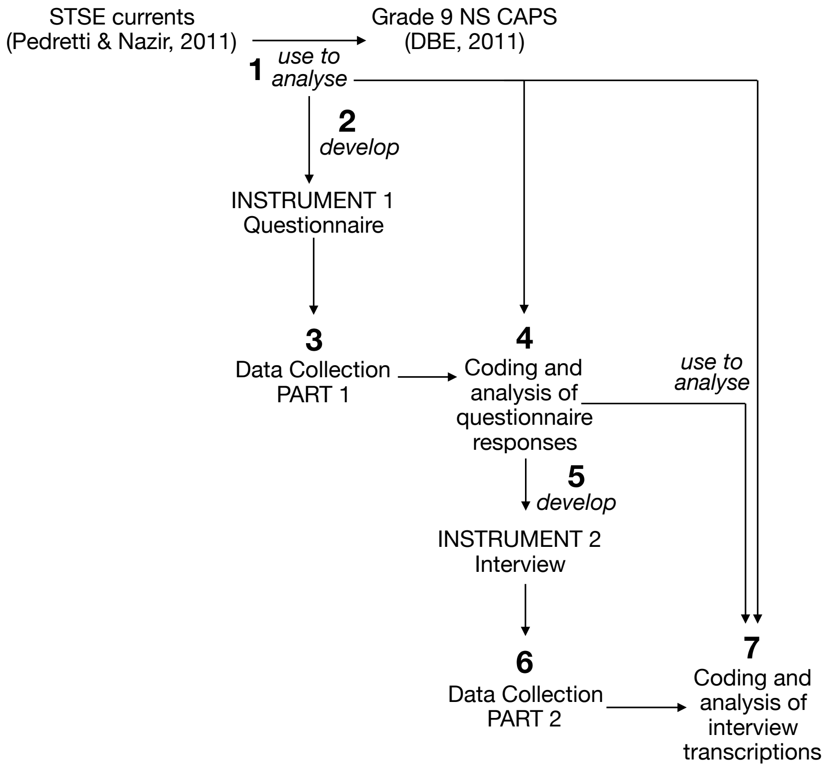


Figure 6: Overview of research design

3.3 Sampling

Grade 9 NS teachers were recruited from various districts which comprise the Gauteng provincial education department. Clusters of schools in two districts were approached at district teacher meetings. These different clusters were targeted in order to ensure a fair representation of the different schools across Johannesburg.

3.3.1 Questionnaire sample

For the administration of the questionnaire Grade 9 NS teachers practicing in the Johannesburg region were recruited.

The approach used when sampling was done for the questionnaire was based on non-probability sampling methods. The sample size for this procedure was 32 respondents. The total number of participants was determined due to convenience and access. Since this study was not aimed at the production of generalisable findings it was possible to use a process of convenience sampling. In this situation selection of respondents was dependent on the availability of and access to the desired population (Kothari, 2004). The decision to use this type of sampling process was limited by considerations of available resources of time and cost.

3.3.2 Interview sample

Once this group of teachers was established the semi-structured interviews were conducted. Participants in the interview formed a sub-sample of those who participated in the questionnaire and who indicated on their questionnaire that they would be willing to continue with an interview.

The sample size for the interview was three participants. Purposive sampling methods were thus employed to select three participants. They were chosen based on their number of years of teaching experience. The goal was to recruit a teacher who had only experienced teaching NS using CAPS, a teacher who had experienced the RNCS and the CAPS, and a teacher who had enough teaching experience that they would have taught using all the forms of the curricula revisions.

3.4 Research methods and instruments

This study made use of two instruments which are a questionnaire (consisting of open-ended and closed likert-type questions) as well as a semi-structured interview schedule. Grade 9 NS teachers were recruited from various districts which comprise the Gauteng provincial education department. Clusters of schools in three districts were approached at district teacher meetings. These different clusters were targeted in order to ensure a fair representation of the different schools across Johannesburg. Primary data sources therefore included responses of these teachers in a questionnaire as well as semi-structured interviews. A secondary data source was used i.e. the NS CAPS (DBE, 2011).

3.4.1 Questionnaire

Questionnaire design (App. 5)

A questionnaire (App. 5) was designed using the STSE currents formulated by Pedretti & Nazir (2011) in conjunction with the NS CAPS (DBE, 2011). The concept map shown earlier in Figure 5 shows that an overlap of important science and society themes were identified in the NS CAPS using the structure of Pedretti & Nazir's currents.

Section 2, "Introduction to Natural Sciences" (DBE, 2011:8-13) and Section 3 that is a detailed outline of the content for Natural Sciences (DBE, 2011:17-84) were analysed. Table 2 below describes the sections of the questionnaire (App. 5) and provides a rationale for the inclusion of each.

Section			Research Question Addressed	STSE Current
	Heading	Purpose		
1	Participant general information	This section helped provide contextual details for the sample. Participants were asked about their NS training and teaching experience. This provided an avenue for categorising participants according to which curricula they would have experienced.	This section did not directly answer any of the research questions, but did allow for the collection and analysis of the demographic, tertiary education and teaching experience of the participants in the sample. This information was used when analysing the responses made.	None.
2	Natural Sciences teaching strategies of participant	This section consisted of questions relating to the types of tasks and teaching activities participants used in their NS lessons. The STSE currents were applied to the Section 3 of the NS CAPS and cases where the currents were reflected in the suggested tasks and activities were used to formulate questions.	This section was included to explore how the teachers were valuing and understanding science and society themes in the NS CAPS (Research question 1). Spaces for comments provided further detail.	Historical, Values-centred, Socio-cultural
3	Natural Sciences lesson planning by participant	This section aimed to explore the extent to which teachers adhere to the NS CAPS, and also other potential influences on their lesson planning.	This section helped answer both research questions 1 and 2. The information collected provided insight into the ways the teachers use the NS CAPS. Comments on alternative influences on lessons helped reflect teachers' approach to using materials and contexts that could promote the teaching and learning of science and society topics.	None.
4	Participant views about science and science education	This section inquired about teachers' orientation towards science and what they see as the focus and purpose of Grade 9 science education.	This section helped clarify how teachers value science and society approaches and their general beliefs about the purpose of science education (Research question 2).	Historical, Values-centred, Socio-cultural

Table 2: Questionnaire components and design considerations

Due to time restrictions and personal circumstances the questionnaire could not be piloted. As indicated in the final chapter, this proved to be a disadvantage to the study as it appears that some questions were not always clearly understood.

Administration of the questionnaire

The questionnaire was administered and 32 completed questionnaires were obtained. The questionnaire took participants approximately 15 minutes to complete (App. 5).

The purpose of using a questionnaire was to capture the maximum number of participant responses which limited resources and time constraints would allow. With the permission of the Gauteng Department of Education participants were recruited at various district teacher meetings. Willing participant teachers were encouraged to complete the questionnaire at the meeting site although many chose to rather complete the document off site in their own time. These were collected from their schools at a later date. A participant information sheet (App. 2) was provided as part of the appeal for participants. Along with the questionnaire willing participants also completed and submitted an informed consent document (App. 1).

Questionnaire participants were asked whether or not they would be willing to participate in the interviews. From the submitted questionnaires willing participants were selected to continue into the interview phase. Interview participants were chosen from this category of affirmative responses.

3.4.2 Interviews

The inclusion of a semi-structured interview (App. 6) in the second phase of the data collection had the purpose of gathering more detail about the issues explored in the questionnaire. This also provided an opportunity to emphasise and comment on contextual and socially significant factors influencing participants' responses. The use of an interview therefore was useful in that, "there is greater flexibility under this method as the opportunity to restructure questions is always there" (Kothari, 2004:98) and hence valuable insights which were not uncovered in the questionnaire responses were gained. This was particularly important in addressing the critical aspects of the conceptual framework.

During the individual semi-structured interview three of the participants were asked to answer a set of open-ended questions which were aimed at uncovering their conceptualisation of Specific Aim 3 whilst obtaining more in-depth and detailed information about their professional experiences, teaching context, and personal beliefs and attitudes. The guiding focus, however, was on participant teachers' views on the purpose of South African Science education, especially in relation to our current curriculum specifications focused around Specific Aim 3. From a review of relevant literature, aspects which influence a teacher's approach to science education were identified. These themes were then used to formulate the interview questions with the Grade 9 NS CAPS used as reference in raising relevant issues. This part of the data collection therefore was aimed at following up on more in-depth aspects and nuances of the issues being explored. The interview took place face-to-face and individually so that participants were assured of confidentiality and anonymity and would not be affected by opinions of any of the other participants.

The interviews were transcribed for further analysis (Appendices 9, 10, 11).

3.5 Data analysis

Operating from a qualitative and inductive framework data collected was coded according to certain themes and patterns in responses from both the questionnaire and the interview transcriptions. This is supported by the statement, "the qualitative data analysis process is a highly intuitive activity. As such it is its epistemological nature and assumptions that make qualitative data analysis a rich and often intricate exercise" (Krauss, 2005:763).

The focus categories were first roughly outlined according to the six STSE currents formulated by Pedretti & Nazir (2011) alongside the NS CAPS (DBE, 2011). The questionnaire was designed along common important themes and categories. The questionnaire responses were then coded and recorded accordingly. A type of triangulation was then possible from the three phases of data collection. Themes and patterns could then be identified across all three phases. This formed the basis for further comments on findings. Data analysis is discussed in further detail in the next chapter.

3.6 Rigour in the research

Golafshani (2003) contended that, "credibility, neutrality or confirmability, consistency or dependability and applicability or transferability are to be the essential criteria for quality" (Golafshani, 2003:601). In defending the rigour in this study it was important to be consistently mindful of each stage of the design, data collection, and data analysis. By providing transparent and critical accounts of each stage of the data handling it was hoped to convince the reader of the trustworthiness and credibility of the study (Golafshani, 2003:601; Krauss, 2005:764). In utilising both a questionnaire as well as an interview, in conjunction with a hermeneutic analysis of the NS CAPS (DBE, 2011), this study aimed to ensure degrees of reliability and validity (Golafshani, 2003:604).

3.6.1 Reliability and dependability

"To ensure reliability in qualitative research, examination of trustworthiness is crucial" (Golafshani, 2003:601). As suggested by this argument a degree of trustworthiness could be achieved by referencing the open-coding system and mechanisms within the framework of the STSE currents. As such the ways in which the data was coded and analysed was able to withstand critical evaluation by other researchers and educators.

3.6.2 Validity

Some qualitative researchers have argued that the term validity is not applicable to qualitative research, but at the same time, have realised the "need for some kind of qualifying check or measure for their research" (Golafshani, 2003:602). By incorporating suggestions for using "triangulation as a strategy for increasing the validity of evaluation and research findings" (Yeasmin & Rahman, 2012:154) it was hoped to validate common themes and findings across each phase of data collection and analysis. In doing so the degree of trustworthiness of the findings could be discussed and evaluated. With the additional layer of data collection and triangulation the semi-structured interviews provided the opportunity to ensure that the account of the participants was accurately and credibly reported on.

By making use of the tasks and phrases teachers would be accustomed to seeing in the NS CAPS the face validity of the questionnaire was ensured.

3.7 Ethics

It is important to note that, "research, and teacher research in particular, requires a careful consideration not only of what the data reveals but also of how that data is acquired" (Stribling, 2013:2). Thus, participants were made aware of the intended use of data collected in the participant information sheet (App. 1). This assured participants that the data would only be used in academic contexts of research presentation or publication and that no personal or identifying information would be revealed.

Completed questionnaires were assigned participant numbers to ensure that specific names were not shown. Once responses were captured these completed questionnaires were securely stored and not accessible to any person outside of the study. Participants were thus assured of confidentiality and anonymity. Participants who were willing to continue with the interview phase needed to provide their contact details on the informed consent form they submitted (App. 1).

Confidentiality during the interviews was communicated and assured to participants by means of precise and clear wording in the Informed Consent form (App. 1) as well as ensuring that there were no other people in the room during the interview other than myself and a single research participant. The electronic transcripts did not contain any of the participants personal identification details and participants continued to be referred to by means of the identification numbers assigned to them in the questionnaire phase.

All data collected was securely stored in a locked cupboard in my supervisor's office at the Wits School of Education.

Participants were reminded that their participation was entirely voluntary, and that they were entitled to decide to withdraw from the study at any point even after the data collection phase had been completed. This helped to ensure that participation was not coerced in any way and that willing participants felt comfortable with their rights and safety (CFE Research, 2014:3).

As no vulnerable or under-age participants were considered in this study the potential for risk or harm was minimised.

3.8 Conclusion

This chapter has outlined the research design used in this study. This included an explanation of the research procedure, the instruments used to collect the data, the sampling procedures as well as issues of reliability of the study. The next chapter explores the results and findings of this study.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Overview of the chapter

The following chapter reports on and discusses the research findings of this study. I begin with an explanation of how the data was analysed. This is followed by the presentation and discussion of the important themes which arose from the analysis which provides the basis for answering the research questions in this report.

4.2 Data analysis

The analysis of the data collected was done in two phases. The first phase examined the data collected from the questionnaire. Using a thematic analysis as proposed by Braun & Clarke (2006) the following process was followed. Recurring patterns observed in responses guided the initial coding process (Braun & Clarke, 2006). This involved working across all the data collected from the questionnaires and applying loose coding to the entire data set.

The second phase of data analysis involved the examination of the three interviews which were conducted after the questionnaire analysis had been completed. The three interviews were transcribed. Once again I made use of the thematic analysis approach which followed the phases outlined by Braun & Clarke (2006). The themes and codes which occurred in the questionnaire analysis were used as a starting point for coding the transcriptions.

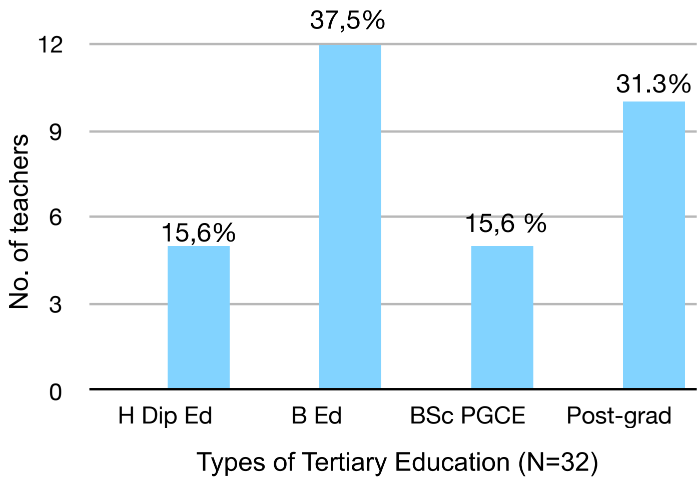
4.3 Results and discussion

My aim in answering the research questions was to determine the ways in which Grade 9 NS teachers read, understand and use the Grade 9 NS CAPS (DBE, 2011). I was specifically interested in science and society themes in this regard. The questionnaires allowed for an overview of 32 teachers' understanding and approaches to teaching science and society with the NS CAPS (DBE, 2011) as their guide. The interviews allowed for a more in-depth exploration of three teachers' beliefs about and views on science and society themes as they understand these from the Grade 9 NS CAPS (DBE, 2011). The interviews also allowed me to capture the three participants' views on the aims of science education as influenced by the Grade 9 NS CAPS (DBE, 2011) and their personal experiences.

4.3.1 General discussion of the participants

There were 32 participants (N=32) who completed the questionnaire (App. 5). The majority were women with the group consisting of 23 women and 8 men (one participant did not respond to the question of gender, n=31). All of the participants were teaching Grade 9 Natural Sciences. The sample included teachers from Gauteng Department of Education (GDE) schools from the Johannesburg-West and Johannesburg-North districts in Gauteng. The schools where participants teach were varied in terms of demographics and available resources.

The graphs in Figure 7 summarise qualifications, age, race demographics and the distribution of home languages of participants. In terms of the age groups, professional qualifications and years of teaching experience in the sample were varied.



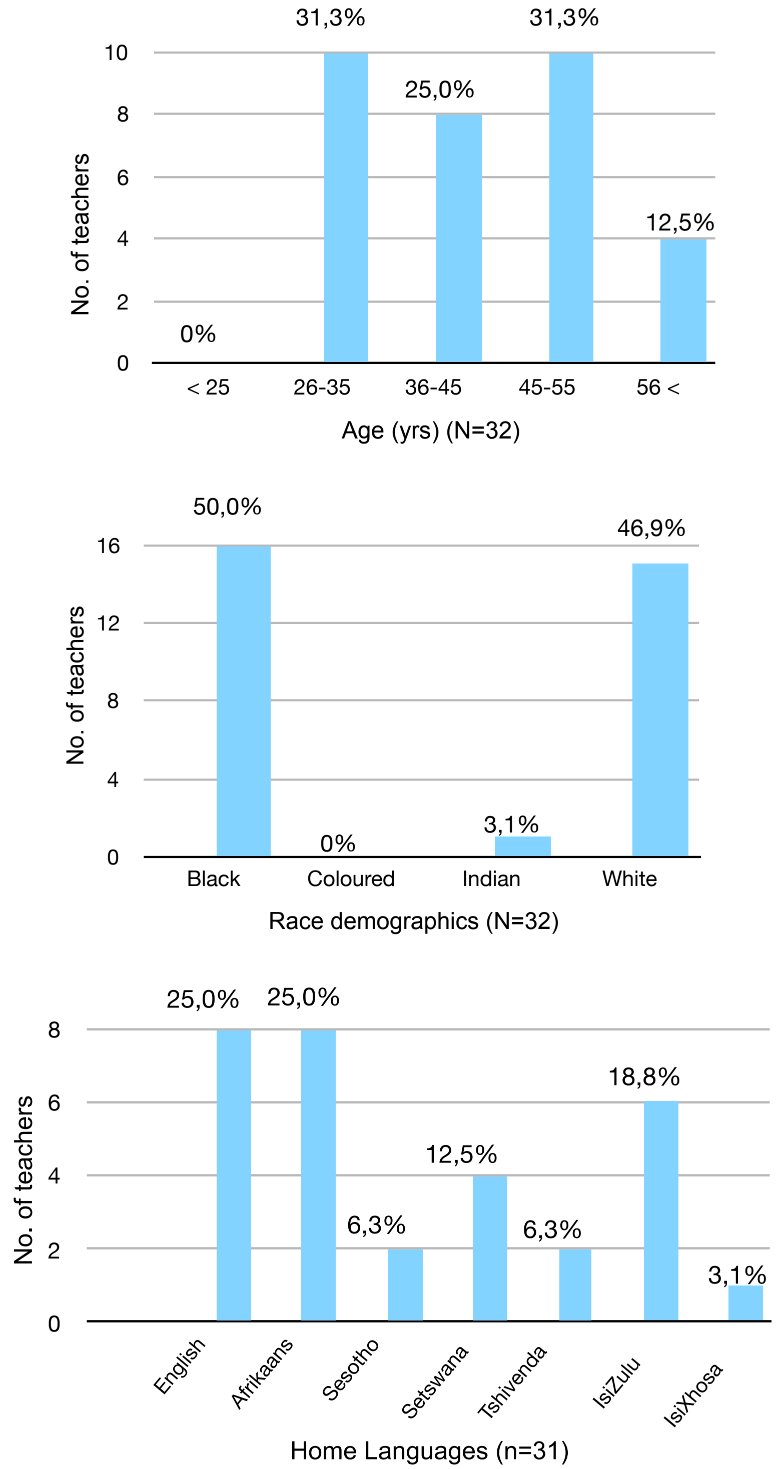


Figure 7: Graphs showing participants demographic information

Approximately half of the participants teach in township schools situated in the Johannesburg-West districts of the Gauteng Department of Education. The remainder of the participants teach in former Model-C schools in the Johannesburg-North districts.

Figure 8 shows the number of in-service NS training hours received by participants provided by the Department of Education (DBE) compared to the hours provided by their School Management Team (SMT).

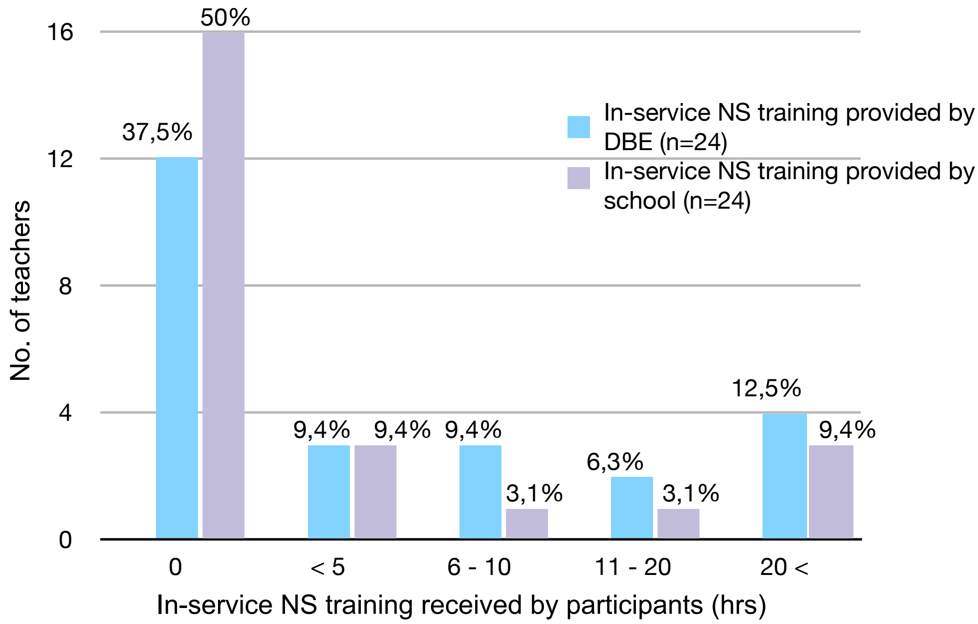


Figure 8: Summary of the amount of NS in-service training received by participants (hrs)

A great portion of participants who responded to this question reported receiving no in-service training at all, either provided by the DBE (37,5%) or by their SMTs (50,0%). The remainder of participants reported varying number of hours of training, which is relative to their years of teaching. In most cases, the participants reported that the DBE provided more training than the SMTs.

I used information about years of NS teaching experience to create three groups of participants. The NS CAPS was first introduced in 2011 (6 years ago). Therefore, teachers with 5 years of teaching experience and less would only be familiar with the NS CAPS (DBE, 2011). These participants were assigned to Group 1. Those with 6-15 years of teaching experience would have experienced two to three different curriculum statements over the course of their careers and were assigned to Group 2. This is because the RNCS was introduced in 2002 (15 years ago). Group 3 consists of participants with experience of 16 years and above who would have experienced all of the significant curriculum transitions since the new democratic administration began. This includes experience of C2005.

Group	NS teaching experience (yrs)	No. of teachers completing the questionnaire	No. of teachers who were interviewed
1	0-5	11	Teacher 1 (2yrs)
2	6-15	17	Teacher 2 (14yrs)
3	16 <	4	Teacher 3 (23yrs)
	TOTAL	**32**	**3**

Table 3: Table showing the assigned groups for participants based on number of years of NS teaching experience

The data in Table 3 shows that 12,5% (12,5%; n=4) of participants, having more than 20 years of teaching practice, would have seen all the Natural Sciences curriculum reforms since 1997.

Participants for the semi-structured interviews were chosen from the teachers who completed the questionnaire. Three teachers were selected based on differences in the number of years of teaching experience. I will refer to the interview participants as shown in Table 3.

4.3.2 Influences on participant lesson planning

The questionnaire (App 5) inquired about the influences on participants' lesson planning. Three main categories were considered. These are the Grade 9 NS CAPS (Q. 3.1-3.2, App. 8), textbooks (Q. 3.3-3.4, App. 8) and on-line resources (Q. 3.5-3.6, App. 8). The following provides a summary of results for each of these questions.

The Grade 9 NS CAPS (Q. 3.1-3.2, App. 5; App. 8)

(Q 3.1: I carefully follow the guidelines in the Gr 9 NS CAPS document when planning my lessons, Q 3.2: comment on Q 3.1).

The greater majority of questionnaire participants reported close adherence to the guidelines of the Grade 9 NS CAPS when planning lessons (Figure 9).

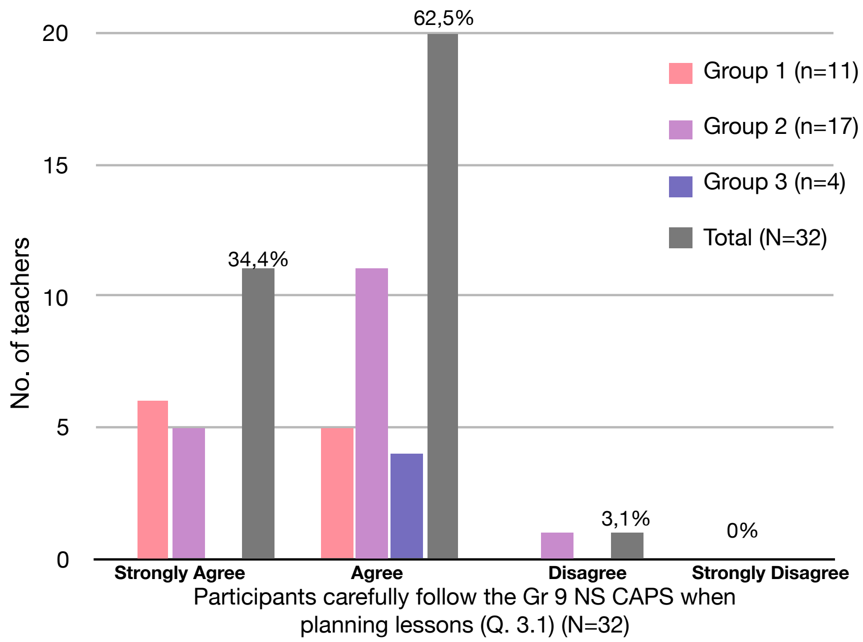


Figure 9: Participants' claims about following the NS Grade 9 NS CAPS when planning lessons

When exploring reasons for the distribution shown in Figure 9, comments of participants are useful to consider (Q. 3.2, App. 8). Some of the main reasons provided for agreement with the statement were ensuring all content was covered for the next grade (29,9%; n=7) as well as national common papers (18,8%; n=6), pace setting (12,5%; n=4), and complying with department checks and regulations (12,5%; n=4). Participants commonly reported that strict adherence to guidelines in fact simplified lesson planning (15,6%; n=5), although none of participants from Group 3 made such reports. Perhaps this is because Group 3 teachers have been teaching for 20 or more years and this experience might make a teacher more aware of what works best for them and less tied to the curriculum.

Some of the questionnaire participants who agreed with the item (as opposed to strongly agreed) reported that they relied heavily on the NS CAPS aligned textbooks prescribed by their schools (12,5%; n=4). Participants report that these textbooks include curriculum specifications, and hence they do not have to read the actual NS CAPS. Participants who disagreed with the statement considered the ability of their students to be of greater importance than the curriculum requirements (15,6%; n=5). Only one participant (P32) made a comment which reported that the curriculum should be followed due to its relevance to South African society. This participant from Group 1 suggested "they [CAPS guidelines] are crafted to societal needs and future needs of the country".

From the interviews it was observed that all three teachers felt pressurised by the amount of science content required to be covered in the Gr 9 year. Teacher 1 expressed the view that she felt that the Gr 9 syllabus was structured predominantly in service of further studies in science and furthermore that it did not provide a sound foundation for senior science courses. She made the comment "I feel that they are trying to squeeze in so much knowledge and content into such small spaces of time and then you end up rushing through it" (App. 9:L28-29). Teacher 1 also expressed the view that the requirement of the covering of content results in assessment focused learning. Teacher 3 lamented that she could not include as many social issues as she wanted to because "opportunity is not there with the curriculum we are just too busy" (App. 11:L15-16). She felt the curriculum was too theory-laden and said, "there's too much to cover, theory, you know, there's too much" (App. 11:L50-51). Such pressures were also confirmed by Teacher 2 in commenting about "time constraints" (App.10:L74) and expressing that, "time is a serious problem" (App. 10:L214).

It is clear that the teachers make use of the NS CAPS when preparing lessons. They predominantly make use of Section 2.9 which outlines a "detailed summary of Natural Sciences concepts and content, and time allocations" (DBE, 2011:56-84) and is essentially the work schedule for the content to be taught each week. Their comments refer to this section of the curriculum document when reporting on compliance with department checks and regulations, pace setting and covering required content for further studies and common examinations. In this sense I would argue that participants are making use of the NS CAPS in a prescriptive and technical manner and not as a reference for pedagogical approach and theory such as the preamble prescribe (DBE, 2011:4-10). This idea is supported by research investigating the implementation of the CAPS curriculum (Maharajh, et al., 2016). In improving on earlier versions of curricula, CAPS provides teachers with "clarity of the requirements of what is to be taught and learnt on a term-by-term basis" (Maharajh, et al., 2016:382). Maharajh et al. argue that this situation does not encourage teachers to critically make decisions about what to teach and how to teach it as the teachers are managed by the curriculum document. This is confirmed by the comment made by a questionnaire participant speaking of influences on lesson planning, "the ATP [annual teaching plan] will inform me and also the work schedule thereafter I will use the textbook as a resource" (P29).

During her interview Teacher 2 argued that the preamble to the NS CAPS are important for promoting the development of "scientifically literate students" (App. 10:L65). However, she felt that the work schedule section of the NS CAPS, which is titled Section 2.9, does not incorporate aspects of the focus of the preamble. She explains that she thinks the sentiments of the preamble are "not fully expressed in the schedule" (App. 10:L73).

Using textbooks (Q. 3.3-3.4, App. 5; App. 8)

(Q 3.3: I rely primarily on textbooks to determine what I teach, Q 3.4: comment on Q 3.3).

Participants reported relying heavily on textbooks for lesson planning. However, far fewer teachers agreed than those who agreed concerning their use of the Grade 9 NS CAPS.

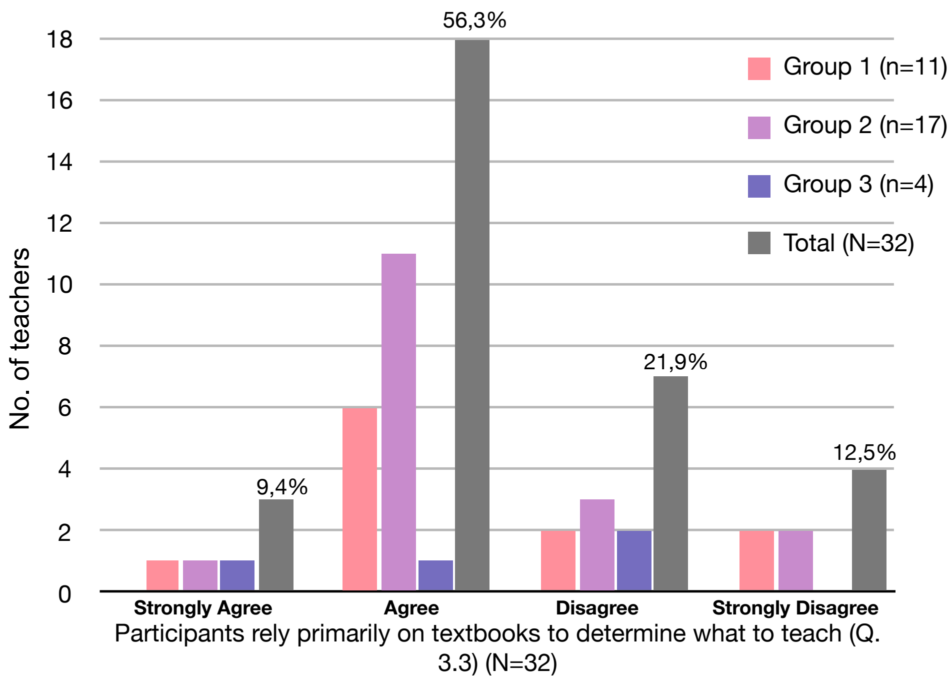


Figure 10: Participants’ reliance on textbooks to determine what to teach

Reasons for participants reporting reliance on textbooks include prescribed textbooks being Grade 9 NS CAPS aligned (29,9%; n=7). Some participants reported experiencing the need to use multiple Grade 9 NS CAPS aligned textbooks in order to meet the curriculum requirements (25,0%; n=8). Participants commonly reported reference to other sources of information to better inform their own personal conceptual understanding of topics before lessons (25,0%; n=8). Related to this, participants commented on the importance of ensuring they are informed of current developments relating to concepts before teaching lessons (9,4%; n=3). Some participants also reported creating their own worksheets and learning materials which combine different types of references (29,9%; n=7). Some participants listed the name of the textbook that they rely on as the only reference in planning lessons (9,4%; n=3). A few participants reported that the prescribed textbook for their school was the only viable resource for their lesson planning as they were uncomfortable with using information technology (6,3%; n=2).

During the interview Teacher 2 commented on the use of CAPS aligned textbooks. She confirmed some of the sentiments of the questionnaire participants in their comments that the use of only one textbook was not sufficient in addressing all topics equally well (App. 10). A questionnaire participant commented that, "there is no textbook with all the information needed" (P26).

In saying, "I feel maybe it's not the curriculum that's failing, but the textbooks that are supplied" (App. 10:L54-55) Teacher 2 expressed the view that science and society aspects of the NS CAPS are not sufficiently considered in CAPS aligned textbooks. She qualified her statement by arguing that, "the history of science and the relationship of natural sciences to other subjects is also very poorly touched on in textbooks" (App. 10:L60-62).

Using on-line resources (Q. 3.5-3.6, App. 5; App. 8)

(Q 3.5: I regularly make use of on-line resources to help me plan my NS lessons, Q 3.6: comment on Q 3.5).

Approximately 69% of participants reported making use of on-line resources when planning their lessons. Figure 11 shows that participants in Groups 3 and 2 were more reluctant to make use of on-line resources.

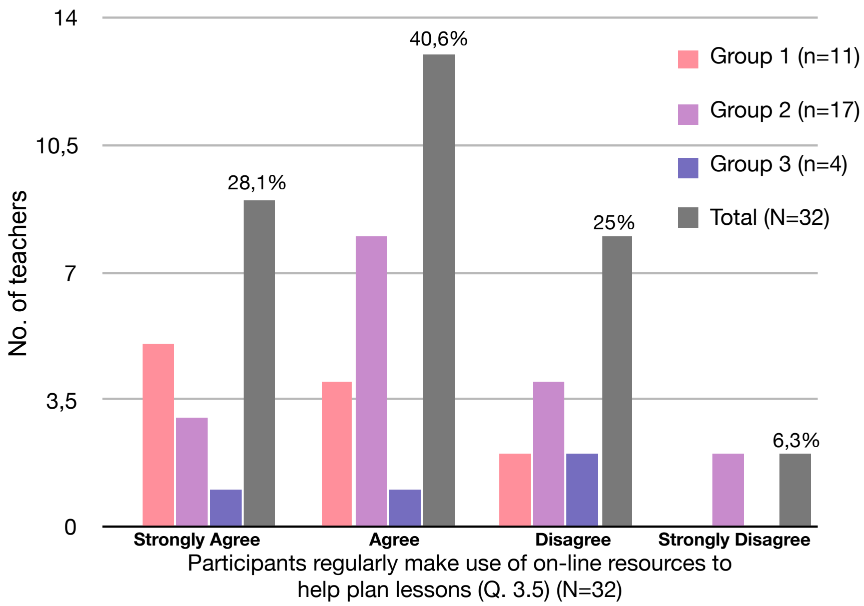


Figure 11: Participants' use of on-line resources when planning lessons

Some participants reported that they did not feel they had time to consult on-line resources (9,4%; n=3). Others who said they did not make use of the internet explained that they were not comfortable with using technology in general (9,4%; n=3) or that they did not have access to the internet (9,4%; n=3). Others who did not use on-line resources felt that the information available on the internet was not applicable or useful to their specific teaching contexts (6,3%; n=2).

Participants who reported making use of on-line resources mentioned three main reasons for doing so. The first reason was to connect with greater teaching and educational communities and access shared resources (29,9%; n=7). However, none of these participants reported using specifically science and society resources in this regard. Examples they gave related more directly to the teaching of scientific concepts. The second reason teachers make use of the internet is for sourcing teaching aids such as diagrams, videos and simulations (29,9%; n=7). Again, examples were given which communicated that teachers used such aids in order to better explain scientific concepts they are teaching. Lastly, teachers reported making use of the internet due to the constantly changing nature of scientific knowledge and application (31,3%; n=10). Zeidler & Nichols (2009) argue that using on-line resources is essential for science teachers looking for science and society references and contexts. They suggest that educators "engaged in SSI would need to rely on research and current information about a given topic to better direct classroom debates through various lines of questioning" (Zeidler & Nichols, 2009:51). However, none of the participants provided examples where they used the internet to source a science and society link or context.

Teachers not making use of on-line resources reported that reading magazines and newspapers, listening to the radio and watching television influenced their lessons (29,9%; n=7).

Maharajh et al. (2016) report that limited access to technological teaching resources is a factor which impedes the implementation of the CAPS curriculum. These authors also argue that teachers view themselves as curriculum implementers and not as curriculum planners due to the highly prescriptive nature of CAPS (Maharajh, et al., 2016). Because CAPS was introduced to clarify what teachers should teach, it therefore has the potential to discourage critical thinking when teachers make decisions during lesson planning (Maharajh, et al., 2016). The inquiry into the influences on teachers' lesson planning in my study showed evidence that participants mostly followed the Grade 9 NS CAPS document without deviation.

4.3.3 Teacher beliefs about science and science education

The following explores participants' views on the nature of science and the goals of science education (App. 5: Section 4; App. 8).

Understanding how science is used in the real world
(Q. 4.1, 4.5, App. 5; App. 8)

(Q 4.1: It is important for Gr 9 NS students to understand how science is used in the real world, Q 4.5: The Gr 9 CAPS specifications provide students with opportunities to connect science they learn in school to experiences outside the classroom).

Participants felt strongly that students should be able to understand how science is used in the real world (Figure 12). Group 1 emphasised this in particular. Participants agreed with this idea predominantly in relation to improving students' understanding of scientific principles and facilitating the development of scientific ways of thinking about the world (37,5%; n=12).

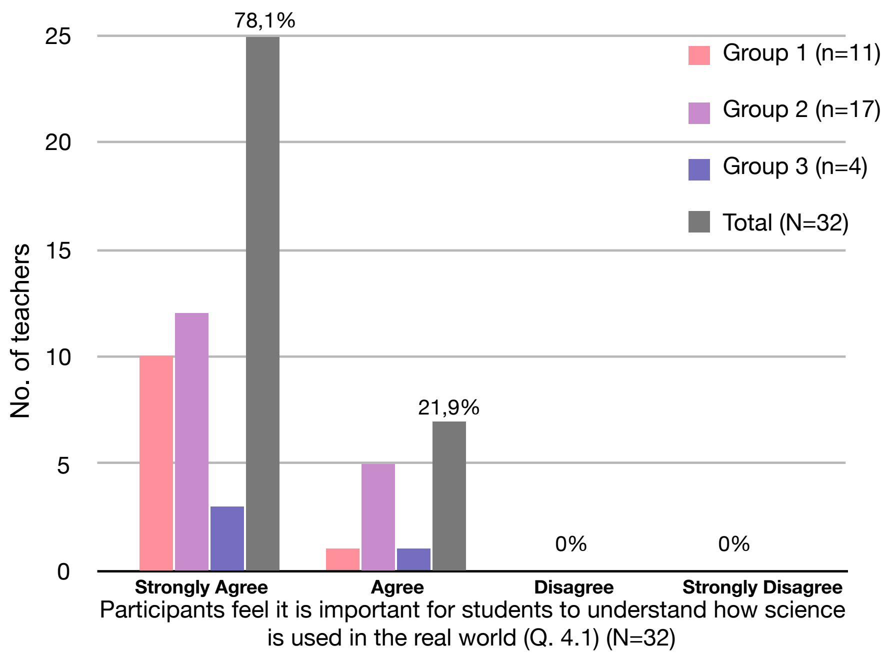


Figure 12: Participants' views on the importance of students understanding how science is used in the real world

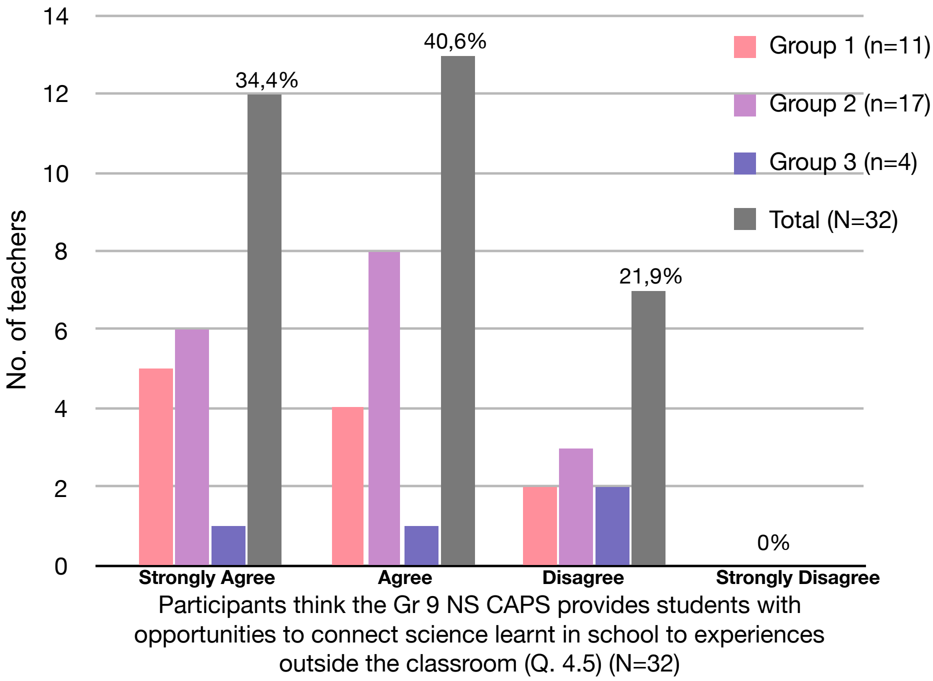


Figure 13: Participants' views about the CAPS allowing for students to see how science is used in the real world

50% (n=2) of Group 3 participants and 21,9% of all participants felt that the Gr 9 NS CAPS does not provide students with opportunities to connect the science they learn in class with experiences outside of the classroom.
During the interviews (App. 9, 10, 11) all three teachers were asked their views about the opportunities for relevance to the students' lives provided by the NS CAPS. Teacher 1 felt strongly that the curriculum does not provide opportunities for relevance (App. 9). She justified her response by explaining that certain terms and topics are predominantly oriented towards scientific theory and principles and that in order to complete the specified work, a focus on the theory needs to be a priority. She explains that, "in terms of just taking Chemistry and making it relevant to them, literally through the entire term, the whole chapter for this term, there is very, very little, there's a lot of theory and very little that actually relates it to real life" (App. 9:L57-59). She also made the argument that although the NS CAPS provides opportunity for practical demonstration of scientific concepts such examples although practical are still not relevant to students' lives (App. 9).

In responding to this item Teacher 2 felt that certain topics provided opportunities for relevance (App. 10). However, she confirmed the comments made by Teacher 1 in suggesting that the time and content allocated for certain sections necessitate that they be taught in a predominantly theoretical way in order for foundations for further studies to be put in place. Teacher 2 explained that once these sections have been taught in the junior grades, applications and relevance are established only in senior grades (App. 10). This results in teachers having to "leave bits of information in isolation, and there's no integration of the information then" (App. 10:L84-85). Teacher 2 suggested that it is largely due to the efforts of the teacher that relevance is provided to concepts specified in the NS CAPS.

Teacher 3 felt that, "there is not enough development of tasks" (App. 11:L43-44) specified in the NS CAPS for providing opportunities for relevance. She argued that the "NS statement is very broad, and it's still very theoretical" (App. 11:L43). She expressed the view that there are science programs more oriented towards science and society (specifically environmental programs) which would allow students more opportunity for relevance (App. 11). Teacher 3 argued that the NS CAPS did not offer examples of "hands on tasks on daily science" (App. 11:L47). She expressed the view that, "it would be nice if we had the time to discuss everything, what the kids experience at home and the environment and society, but there's too much to cover, theory, you know, there's too much" (App. 11:L49-51). Teacher 3 raised concern about the aims of the curriculum in attempting to be relevant to South African students living in very diverse contexts and communities (App. 11). She claims to contextualise the curriculum content by providing time for "issues the kids experience here in the city, say for example, the flooding of the roads when that happens, or the pollution problems and the connection to respiratory disease" (App. 11:L109-111).

Orientations to science teaching (Q. 4.2, 4.7, App. 5; App. 8)

(Q 4.2: It is important for Gr 9 NS students to remember formulae and procedures, Q 4.7: Gr 9 NS is mostly important in preparing students to be able to take science in the FET band).

When considering the participants' views on science education, the questionnaire aimed to uncover possible scientistic orientations and approaches to teaching NS.

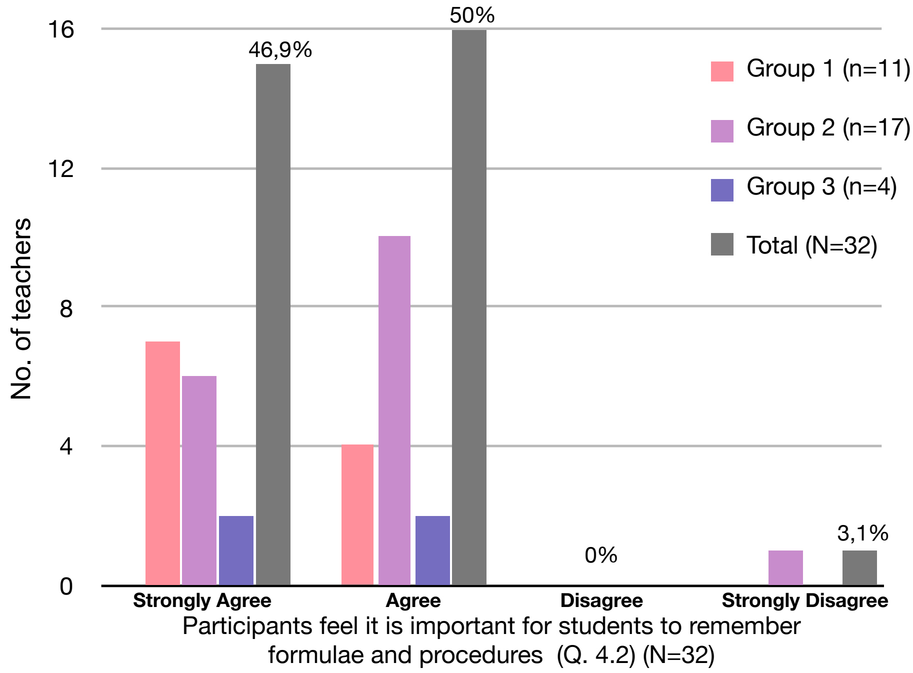


Figure 14: Participants feel it is important for students to remember formulae and procedures

In summary, most participants felt that it was important for Grade 9 students to remember formulae and procedures (Figure 14) as part of their science learning. Group 1 participants, those familiar with only the NS CAPS curriculum, as well as Group 3 (the most experienced teachers) all agreed to this item.

It can be argued that remembering formulae and procedures is mostly relevant in completing scientific questions and problem-solving from within a scientific culture or way of thinking and is related to preparing students for further studies in science. Research shows that students do not use scientific procedures and thinking to solve problems they encounter in their daily lives (Aikenhead, 2003a). It can then be assumed that participants are thinking about students' performance in the school subject of science when answering these two items.

Figure 15 shows that most Group 2 participants agreed that Gr 9 NS is important to prepare students to take science at a senior level.

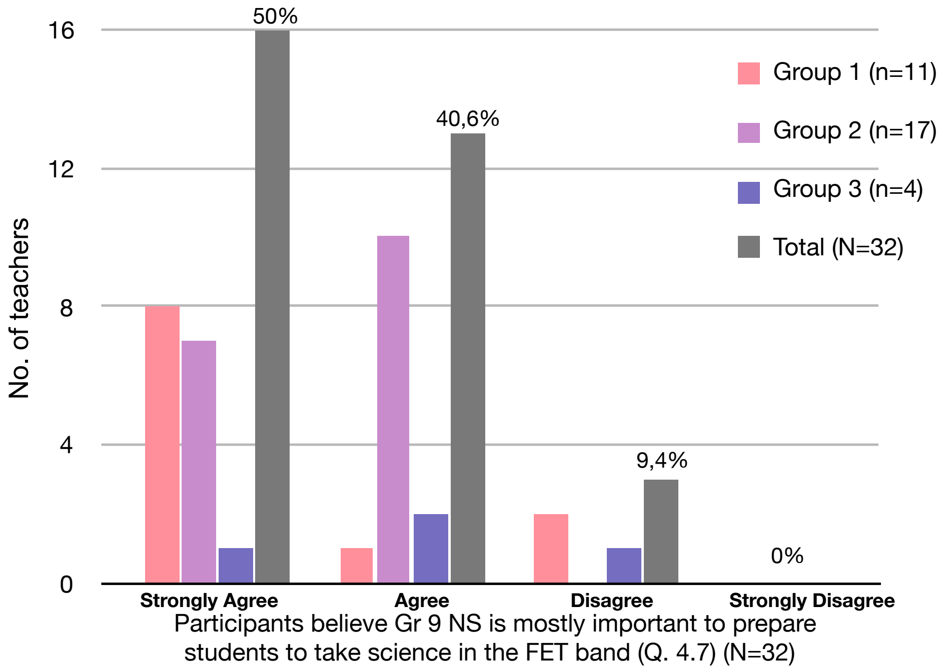


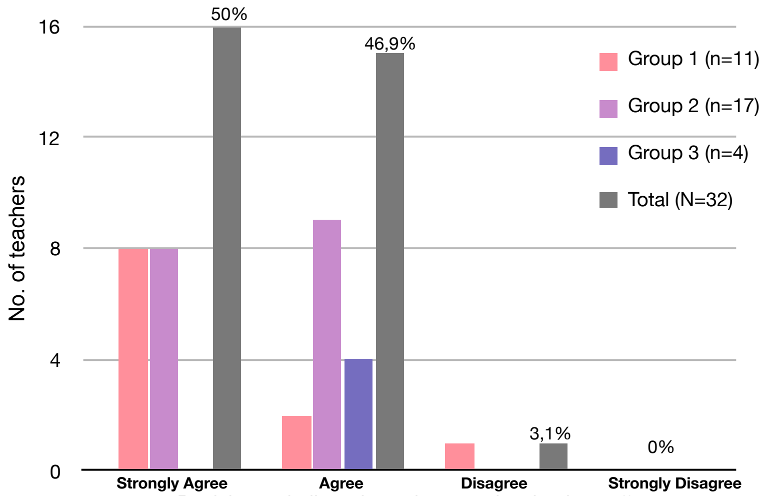
Figure 15: The extent to which participants agree Gr 9 NS is mostly important to prepare students for science in the FET band

The interviews showed that all three teachers viewed their role in the NS classroom as predominantly to develop the discipline of science and to encourage students to think scientifically. Teacher 1 felt that her main goal in junior science was to provide students with a taste of what further studies would entail and in doing so help students make decisions aligned with their interests regarding their senior subject choices (App. 9). She inferred that students who found certain sections too theoretical, or too difficult, would be discouraged from taking FET subjects which contained those sections. She refers to the Chemistry section in Matter and Materials when explaining this further (App. 9). Teacher 2 explained that as a science teacher a "level of consistency is definitely necessary" (App. 10:L33). This is to ensure that the technical skills of the scientific discipline are adequately communicated and instilled in students (App. 10). She argues that, "because it's a science you have to have that discipline, especially in your hypothesis testing" (App. 10:L47-48). Teacher 3 argues that her primary objective as a science teacher is "at the end of the day ... trying to train kids in the scientific method and in understanding and in questioning" (App. 10:L86-87).

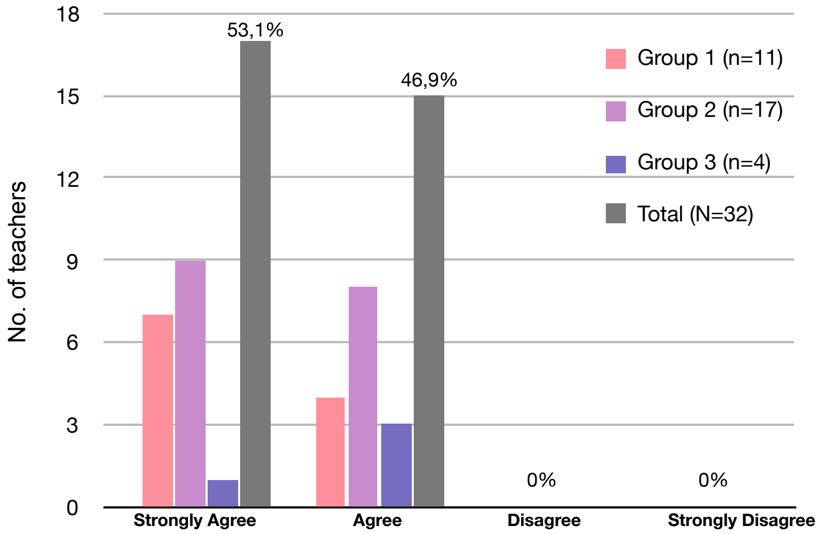
The more experienced participants in the questionnaire disagreed over the importance of Gr 9 NS in preparing students to take science in the Further Education and Training (FET) band. However, because this Group 3 all agreed that remembering formulae and procedures is important for NS students, it is possible that they are thinking about the drop out numbers from Grade 9 to Grade 10 from their experience, and not about the value of junior science education specifically. The importance of Grade 9 NS in preparing students to take science in the FET band was also echoed by Teacher 1 and Teacher 2, participating in the interviews (App. 9; App. 10).

Views on social and environmental problems
(Q. 4.3, 4.4, 4.6, App. 5; App. 8)

(Q 4.3: Science and technology offer a great deal of help in resolving social problems such as poverty, crime & unemployment, Q 4.4: Science and technology can fix environmental problems in the future, Q 4.6: Technological developments can be controlled by South African citizens).



Participants believe that science and technology offer help in resolving social problems (Q. 4.3) (N=32)



Participants believe that science and technology can fix environmental problems in the future (Q. 4.4) (N=32)

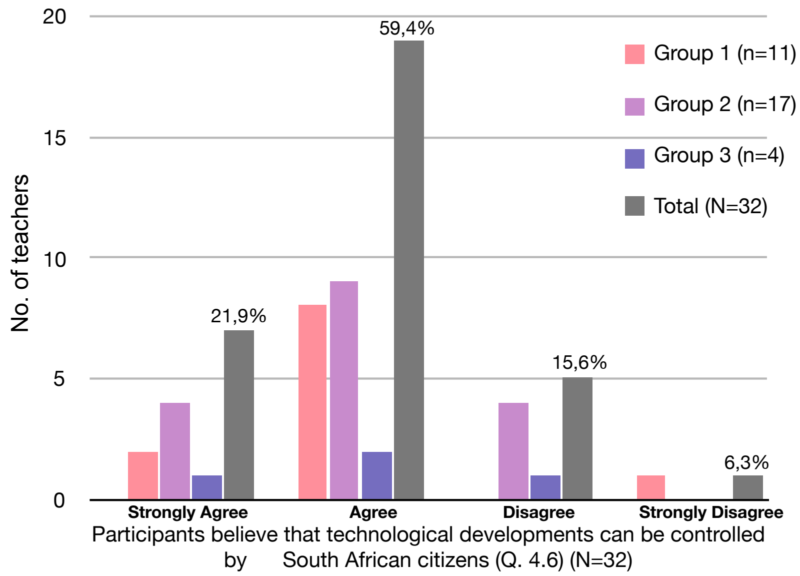


Figure 16: Graphs summarising participants beliefs about science and technology

When considering participants beliefs about scientific knowledge and importance of technological development, it is clear that they predominantly feel that science is vital in the solution of social and environmental problems faced by South Africa. Most of the participants, particularly the younger teachers believe that technological developments can be controlled by South African citizens. This information is summarised by the graphs in Figure 16.

In summary, participants conveyed beliefs in the essential importance of science. In some cases participants expressed ideas about the superiority of scientific knowledge and scientific explanation. Participants generally advocated the process of enculturation of students into scientific ways of thinking and reasoning. Such sentiments are confirmed by comments such as "our more scientifically open learners come from better structured homes and are academically more inclined to achieve" (P15). Participants also communicated a lack of consideration of the cultural aspects of science by making comments such as "unfortunately the view out there is that science is difficult and only clever people can do it ... as soon as people realise that that is not true, but it depends on the amount of effort that you put in, the more it becomes a subject which is more accessible to all" (P9).

Participants generally expressed the importance of students taking science as a subject for ensuring successful careers making comments such as "science gives you more opportunities" (P31) and "it [science] is a prerequisite to further tertiary studies and employment after school" (P7).

Overall participants expressed the sentiment that the focus of junior science education is the teaching and learning of scientific concepts and principles and that science and society themes and issues are secondary to this primary objective. This is confirmed by comments such as "the Grade 9 syllabus is so full that there isn't much time to spend on societal issues" (P3). It can be argued that participants view the development of scientific literacy as a subordinate goal in junior science education.

Participants were sometimes honest about the complexity of incorporating science and society driven approaches to teaching in their lessons. Some felt that such endeavours were beyond their scope of expertise while others emphasised limitations on student abilities. A participant commented that, "encouraging them [learners] to be content creators or problem-solvers can be a teeth-pulling process at times" (P3).

4.3.4 Teacher approaches to science and society

The following presents a summary of participants responses to questionnaire items which relate to the six STSE currents documented by Pedretti & Nazir (2011) but are also referred to in the Grade 9 NS CAPS (DBE, 2011).

Historical (Q. 2.12-2.13, App. 5; App. 8)

(Q 2.12: I make use of case studies showing the history of science in my NS lessons, Q 2.13: comment on Q 2.12).

Approximately 53% of participants reported that they agreed to the use of the history of science (Figure 17).

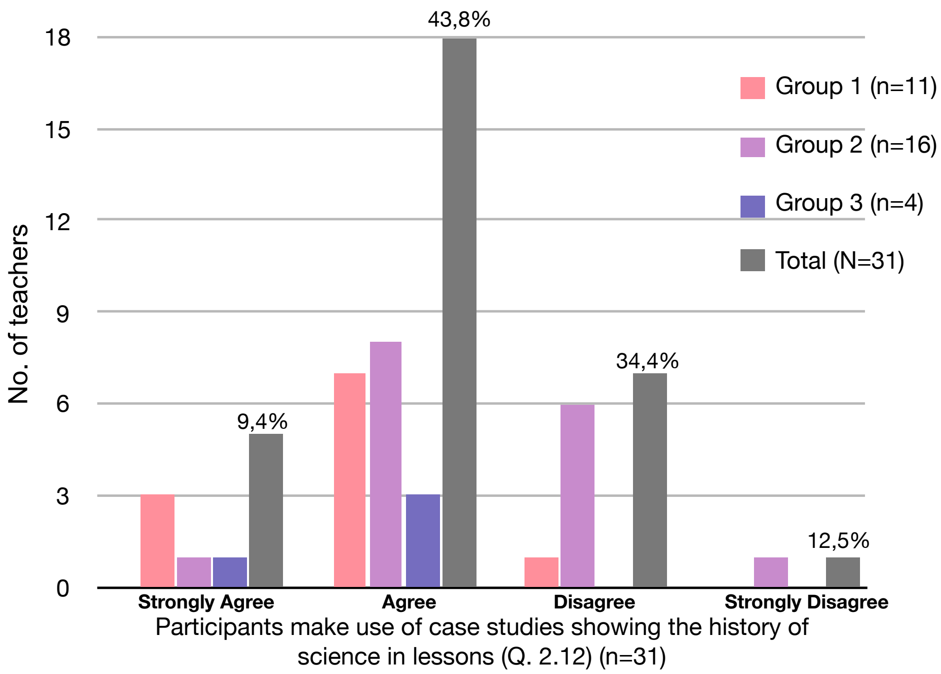


Figure 17: Participants make use of case studies showing the history of science in lessons

The use of the history of science is only referred to in particular in the Life and Living strand of the NS CAPS. Perhaps some of the teachers are more focused on the Physical Sciences elements of the teaching and therefore are not aware of this curriculum specification. However, research shows that the incorporation of the history of science is important. The preamble of the NS CAPS explain that, "a good teacher will tell the learners something of the arguments and confusion among the people who were the first to investigate this knowledge" (DBE, 2011:8). From the data obtained it can be concluded that almost half of the teachers do not make use of the historical approach to teaching scientific concepts and therefore are not incorporating this curriculum specification into their NS teaching.

Pedretti & Nazir (2011) argue that the historical STSE current emphasises "science as a uniquely human endeavor" (Pedretti & Nazir, 2011:603:610). With this focus, the social embeddedness of scientific theories can be illustrated to students.

During the interview all three teachers spoke about their use of the history of science in the lessons. Teacher 1 communicated awareness of the dominance of men and the under-representation of women seen in the development of scientific stories (App. 9). She argues the idea that her students are mostly "westernized" and hence the issue of the dominance of the west in the history of science is not as much a concern as the dominance of men. She explains "I have tried to mention this basically in terms of where are you in the societal structures, that's kind of where it came from, where more knowledge was recognised from males ... but what I do try and emphasise is that we need more female scientists" (App. 9:L108-111). Although showing some awareness of the bias in science, Teacher 1 also explicitly reported that she does not make use of historical case studies in her teaching (App. 9).

Teacher 2 reported that she explicitly makes use of the philosophy and history of science to illustrate the changing nature of scientific knowledge to her students (App. 10). She explains the importance of teaching her students about the differences between scientific facts, theories and axioms (App. 10). She also references the historical conflict between science and religion as an example of her use of the history of science (App. 10).

Teacher 3 reports that she "tends to build on the historical development of science" (App. 11:L70) in her approach to science teaching. She explains that although she is aware that scientific knowledge is continually developing and changing, for the purposes of junior science it is not always beneficial to make the students aware of this. She explains that, "we've got to be careful of bringing too much new information for minds which are not ready to understand the concepts" (App. 11:L72-74). Teacher 1 also confirms this idea in saying, "in terms of scientific knowledge that we teach now, it's like playing catch up, because you're not teaching them anything that is close to being new, any time soon" (App. 9:L80-81). She supports her comment by explaining that science tends to be taught as fact, using simplified models to help lay foundations for complex scientific concepts which students are not yet able to understand and grasp (App. 9).

Pedretti & Nazir (2011) argue that the historical STSE current provides the context for "exploration of complex epistemological questions" (Pedretti &

Nazir, 2011:610). In questioning the nature of scientific knowledge the issue of science being portrayed as "dehumanized and decontextualized" (Pedretti & Nazir, 2011:603) can be addressed. Kolstø (2008) agrees, arguing that including stories from the history of science in lessons facilitates thinking about the Nature of Science (NOS) and science and society relationships.

The data collected shows that almost half of the participants did not make use of historical case studies in their lessons and hence it might be inferred that some teachers are not allowing students opportunity to question the nature of scientific knowledge and its connection to sociocultural contexts. Furthermore, comments made by Teacher 1 and Teacher 3 in the interviews indicate that teachers who do make use of the history of science may do so in a limited capacity in order to maintain the belief in scientific facts for junior students.

Value centred (Q. 2.10-2.11, App. 5; App. 8)

(Q 2.10: I encourage my students to develop their values about social issues related to science in South Africa, Q 2.11: comment on Q 2.10).

84,4% of participants reported encouraging students to develop values about social issues related to science in South Africa. Only 25% of participants strongly agreed with this item (Figure 18).

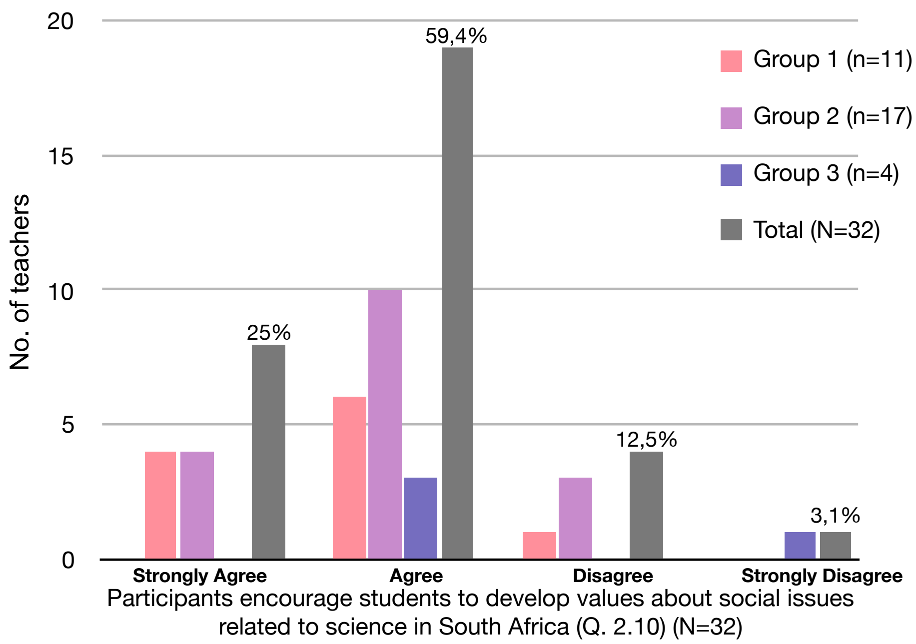


Figure 18: Participants encourage students to develop values about social issues related to science in South Africa

Comments provided by participants gave insight into these reports (Q. 2.11, App. 5; App. 8). Many participants responded to this item by providing specific examples of socially oriented applications of science. Participants differed in the types of examples they provided. Some participants gave examples which were not socially contentious and therefore would not facilitate the development of values for students (6,3%; n=2). Others listed socially contentious issues which would be appropriate contexts for values development. According to SSI frameworks, socially contentious issues which relate directly to the personal lives of students are most effective in value development and clarification (Zeidler & Nichols, 2009). A group of participants communicated this type of context (18,8%; n=6). Comments included "there must be a strong connection between content and everyday life. eg. what does smoking do to your body and those around you. eg. stealing electricity (how does it effect South Africa and not just yourself)" (P12) and ideas about the importance of evaluating learners' "consumption patterns" (P17).

A group of participants commented on the importance of students developing values but did not provide specific details about how this would be facilitated in lessons (34,4%; n=11).

A further category of responses showed that participants felt values clarification was mostly important in terms of developing scientific thinking about the issue being used (9,4%; n=3). Participants in this category also reported that activities associated with the development of values were useful in order to understand the applications of science, but without indicating that they understood the importance of critical evaluation of the social effects of such application (9,4%; n=3).

Those who disagreed with this item gave several reasons for their reports. P15 explained that students are not mature enough to be able to engage with values clarification while P9 felt that science "is a fact driven subject, so we stay on the topic at hand" (P9). Furthermore, a participant regretted that they "don’t know enough about the social issues" (P8). Research reports teachers' apprehension in making use of SSIs for this reason (Kolstø, 2008).

Overall, participants did not communicate a clear understanding of the values STSE current. Pedretti & Nazir (2011) explain that the values current helps to nurture "students' moral and emotional identities to stimulate cognitive and moral development" (Pedretti & Nazir, 2011:614). Interview participants did not express consideration or awareness of being critical of "the value free nature of science" (Pedretti & Nazir, 2011:614). Participants communicated ideas about values in terms of potential links in supporting the demonstration and understanding of scientific concepts and not as tools for facilitating moral and emotional development of students.

Sociocultural (Q. 2.8-2.9, 4.11, 4.12, App. 5; App. 8)

(Q 2.8: I make use of social issues which relate to science in teaching my NS lessons, Q 2.9: comment on Q 2.8, Q 4.11: Traditional African Indigenous Knowledge has an important part to play in South African science education, Q 4.12: comment on Q 4.11).

In order to explore the sociocultural STSE current three items from the questionnaire were considered. The first of these related to participants' general inclusion of social issues in their lessons shown in Figure 19 (Q. 2.8-2.9) while the second (Q. 4.11) and third (Q. 4.12) related to their views on the use and value of alternative ways of knowing (Figure 20) and specifically Indigenous African Knowledge (Figure 21).

The majority of Group 2 participants agreed with the inclusion of social issues in their lessons. Two teachers in Group 3 disagreed with the item with none of this group indicating strong agreement. In total, only four participants reported that they do not use social issues in the NS teaching. Participants in this category gave reasons of time constraints, deviation from scientific content and limited usefulness to justify their reports (6,3%; n=2).

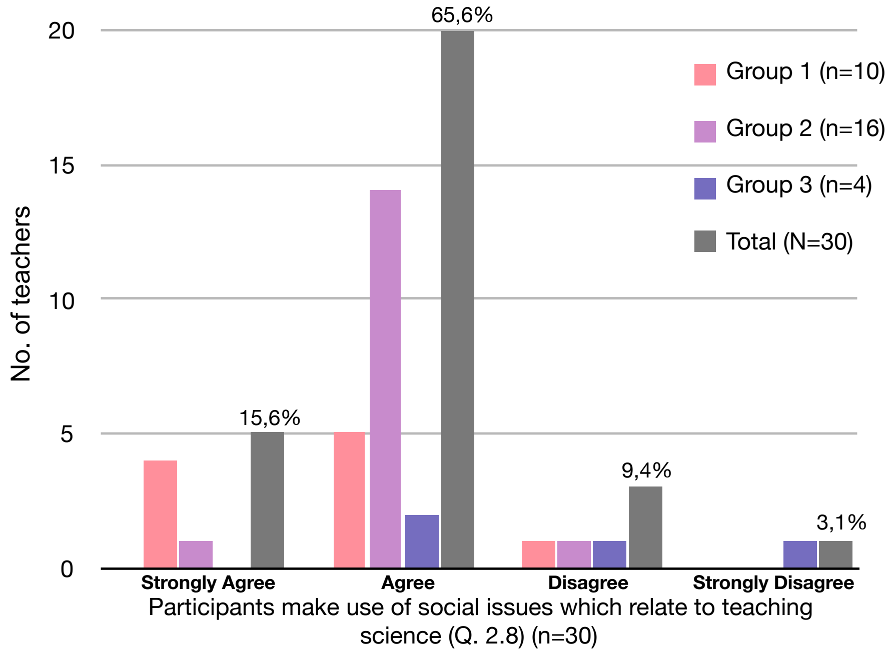


Figure 19: Participants make use of social issues which relate to teaching science

In reviewing comments provided for this item, many participants responded by providing specific examples of social issues they include in lessons. This category of comments was further divided into those who provided examples of social issues which relate generally to society (18,8%; n=6) and those who provided examples that can be directly related to students' daily lives (31,3%; n=10).

Examples given of social issues which relate generally to society included "rhino poaching, global warming, happenings in parliament" (P10) and "pollution issues and impacts on resources" (P15). Examples that can be directly related to students' lives included "food choices of learners, the amount of sugar in those foods and understanding a label on packaging" (P3), and "the impact of load shedding" (P9), and "service delivery" (P19).

Some participants gave reasons for using social issues. Three participants suggested that the use of social issues is valuable in the development of students' self awareness and empathy (9,4%; n=3). A larger number of participants commented on the value of using social issues for the encouragement of interest in science and the development of scientific knowledge (31,3%; n=10). However, this does not emphasise the focus of the sociocultural STSE current which is to make students aware that, "science and technology are not self-contained activities but embroiled in politics, economics, and culture" (Pedretti & Nazir, 2011:615).

In terms of the sociocultural STSE current Pedretti & Nazir (2011) argue that it is imperative for science teachers to make students aware that western science is essentially only one way of knowing about the world. In this way action can be taken "to address the inequitable treatment of alternative knowledge systems and arrest the continuing erosion of non-Western cultures" (Pedretti & Nazir, 2011:616).

Figure 20 shows information collected about participants' views on science as being one of the many ways of knowing and thinking about the natural world (Q. 4.8).

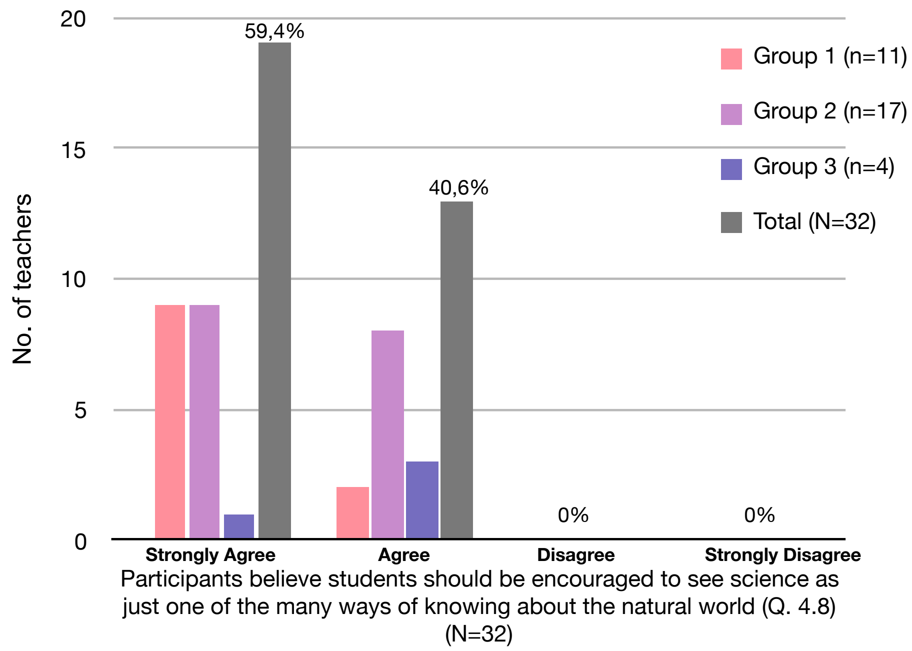


Figure 20: Participants' report on encouraging students to see science as just one way of knowing about the natural world

None of the participants disagreed with this item. However their comments indicated some discrepancy in these reports. Many participants made statements which communicated their belief in the superiority of science in terms of its explanatory value. P2 wrote, “magic is everywhere if you don’t understand science ... science provides an explanation for why things happen". P11 felt that, "everything on earth revolves around Science!". P17 suggested that, "science helps learners to link theory and concepts to the natural world [and] if they can understand the concepts they can apply their knowledge to the real world". P18 believes that, "students need to broaden their common knowledge of the world they live in", showing that P18 was concerned with encouraging students to adopt a scientific way of thinking about their world as opposed to non-scientific, common-sense ideas. A further example of this belief is P16's comment that, "learners need to understand how science is used in the real world because this makes them love the subject and understand the content better".

None of the most experienced teachers from Group 3 felt that traditional African Indigenous Knowledge has an important part to play in South African science education. Group 1 showed a high level of agreement with this item (90,9%) while Group 2 varied in reports with 70,5% agreeing and 29,4% disagreeing. Figure 21 below illustrates teachers' responses to Q. 4.11 (App. 5; App. 8). Question 4.11 explored teachers' views on the inclusion of traditional African Indigenous Knowledge as an important aspect of South African Science education.

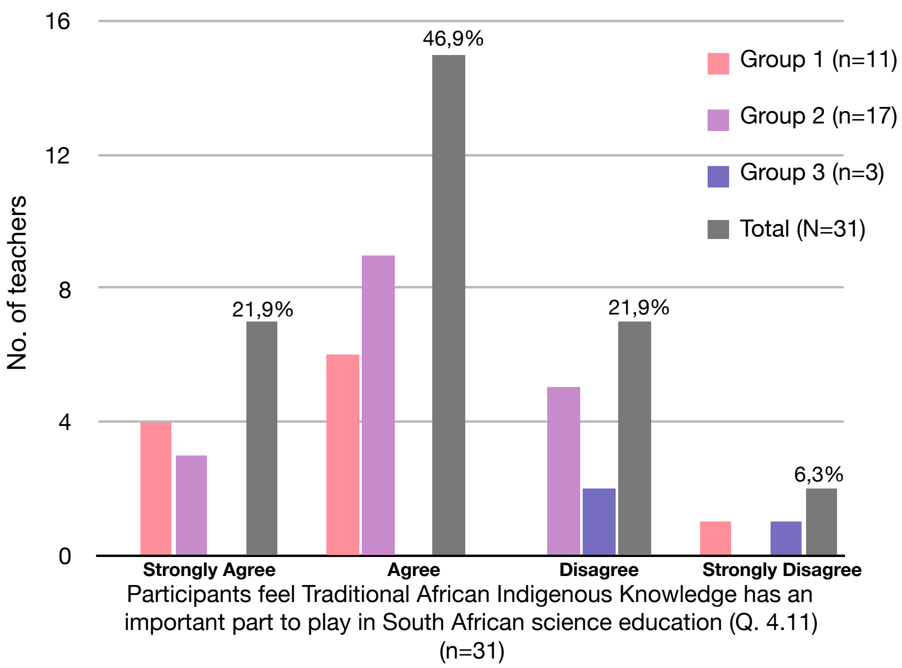


Figure 21: Participants views on the importance of traditional African Indigenous Knowledge in South African science education

Comments that were provided (Q. 4.12, App. 5; App. 8) showed that some participants felt that traditional African Indigenous Knowledge is not appropriately included in a predominantly western oriented body of scientific knowledge (9,4%; n=3). Participants also indicated that they felt that traditional African Indigenous Knowledge was more appropriate if considered as a sub-section of the history and development of science and not specifically as current scientific knowledge (25,0%; n=8).

A group of participants commented in a positive manner by providing examples of traditional African Indigenous Knowledge relevant to science teaching (9,4%; n=3). Such comments included " knowledge of plants for medical science and alternative sources of energy" (P1), and "Indigenous Knowledge about preserving fish and meat, about delivering babies and groom premature ones" (P22). Comments were also provided about the importance of reminding students of the cultural value of such knowledge (25,0%; n=8). Examples of these comments are "there is more than one way to approach a problem and as South Africans we can take initiative in problem solving" (P3), "all science has been informed by basic Indigenous Knowledge along the line somewhere ... this is our land and our resources; our ancestors used it to survive, so it holds a lot of potential" (P15), "traditional African Knowledge is important because it is still science knowledge; the only difference is that it relies more on nature, which is perfect as it offers eco-friendly products or solutions to problems which can be solved using the environment instead of abusing the environment ... I believe that it is important not to forget about Indigenous Knowledge as Science has stemmed from it" (P17), "most of our population used knowledge gained from grandparents and we need to expand on that and encourage the cultural and indigenous aspect" (P18), "traditional African indigenous knowledge to help people in real life" (P21), "learners should know where they come from" (P27), and "learners must know that science is also available in Traditional African Knowledge, for example most plants can be used as medication eg aloe plant" (P30).

Some participants commented on the link between traditional African Indigenous Knowledge and the curriculum specifications by writing, "CAPS document does not have this ... educators have to adapt syllabus to relate to African Indigenous Knowledge" (P13) and "I am sure you can integrate Indigenous Knowledge, but time is restricting us" (P9). Overall the comments showed that teachers believe that the NS CAPS does not directly relate topics to instances of traditional African Indigenous

Knowledge and that if a teacher were to incorporate IKS, it would be in addition to specified topics and would hence take up lesson time allocated to covering the curriculum content.

The participants in the interviews provided comment on their views about the value and use of traditional African Indigenous Knowledge in their science lessons. Teacher 1 reported that she did not make use of IKS at all in her teaching (App. 9). She made reference to the textbooks developed during the implementation of C2005 which was before she trained as a science teacher. She notes that she has observed that, "the textbooks had more passages on indigenous knowledge, like a little reading sections and examples" (App. 9:L102-103). In her opinion the CAPS aligned textbooks have isolated and poorly contextualised instances of IKS which the students find arbitrary (App. 9).

Teacher 2 expressed positive associations with indigenous knowledge and its relevance to her science lessons. However, her comments were about indigenous knowledge in terms of generational knowledge from historical cultures around the world in general and not about traditional African Indigenous Knowledge specifically (App. 10). She expressed awareness of the cultural hegemony of western science by saying:

> *I think that Western science dominates too much. It's that proverbial big dog that's got more clout, so because the western societies have always claimed to develop themselves more, trying to find new knowledge, trying to get better, where as your other systems, your African systems, your Indian systems as well, because they also have their things, but the west because they have more tools they are the louder ones, and other cultures, the way they do things is just very different to the western culture, and the westernised people, they don't like to integrate, they want to be set apart.* (App. 10:L175-181)

Teacher 3 reported that she occasionally might make use of traditional African Indigenous Knowledge in her lessons (App. 11). However, she was outspoken about her belief in the limitations of IKS for students learning science (App. 11). She argues that IKS can be referred to but ultimately should be explained using western scientific thinking in order for such an activity to be of value. She contends that IKS is not always "logical" and able to be applied in different contexts (App. 11). In referring to her multicultural science classroom she made the comment that, "anybody who wants to function in this predominantly western environment needs to adapt to that" (App. 11:L92-93). In this regard Teacher 3 shows little sensitivity to the cultural barriers students may experience when learning science.

Overall it seems that participants find it difficult to constructively and practically incorporate traditional African Indigenous Knowledge into their lessons and therefore have trouble "valuing indigenous knowledge systems [and] acknowledging the rich history and heritage of this country as important contributors to nurturing the values contained in the Constitution" (DBE, 2011:5) as suggested by the NS CAPS.

4.4 Conclusion

This chapter examined the data collected for the study. It started with a description of how the data was analysed followed by a presentation and discussion of the findings revealed in patterns and themes in the data.

Teachers' influences on NS lesson planning were first explored. Following this discussion, teachers' beliefs about science and science education were examined. Finally, teachers' approaches to science and society teaching approaches were evaluated using three of the six STSE currents presented by Pedretti & Nazir (2011).

The following chapter concludes this study by providing an overview of the research process and summarises the findings.

CHAPTER FIVE

CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

The aims and objectives of junior science education in South Africa, specifically at the Grade 9 level, provided the context for this study. The Grade 9 Natural Sciences Curriculum and Assessment Policy states that science at this level aims to develop scientifically literate citizens as well as provide students with appropriate conceptual foundations in scientific knowledge needed for further studies in science.

It is argued that although a contentious concept to define, scientific literacy is important in preparing students for participation in "decision making in the modern technological society for their personal, civic, and professional lives" (Dos Santos, 2009:362). Such an approach to science education is based in humanistic perspectives of science and facilitates the understanding that science is by nature a human activity embedded in social and political contexts (Aikenhead, 2010). Aikenhead (2007) argues that there is a fundamental tension between humanistic approaches to science education and more traditional and technical approaches which aim to "socialise students into a scientific way of thinking and believing" (Aikenhead, 2005:384). He claims that that only a small percentage of students are able to meaningfully learn about science in this way (Aikenhead, 2005).

Ramsuran (2005) argues that since the proposal of transformation ideology as a framework for educational reform in democratic South Africa, certain humanistic nuances seem to have been subtly down-played in the various revisions of the NCS. This is especially true in the case of revisions made to the Natural Sciences policies, and specifically in relation to science and society philosophies and educational frameworks (Ramsuran, 2005). The resulting and current Grade 9 NS CAPS (DBE, 2011) seems to remain oriented towards more traditional approaches to science education (Ramsuran, 2005).

In order to effectively respond to the needs of modern society Mansour (2009) contends that science and society approaches to science education be given higher priority. The foundation of such ideology is the preparation of scientifically literate citizens and the extensive development of intellectual ability geared towards responsive and empowered citizenship (Mansour, 2009).

This study explored how a group of South African science teachers conceptualise, use and value science and society themes as they are presented in the NS CAPS (DBE, 2011). The STSE currents presented by Pedretti & Nazir (2011) provided a theoretical framework from which this inquiry was conducted and structured.

5.2 Summary of findings and conclusions

The following discussion summarises the findings of the study in relation to the research questions. Its is helpful to refer again to Figure 5 which is is a sub-section of Figure 1 and shows the conceptual focus of this study that evaluates how teachers are conceptualising and using science and society themes in the Grade 9 NS CAPS.

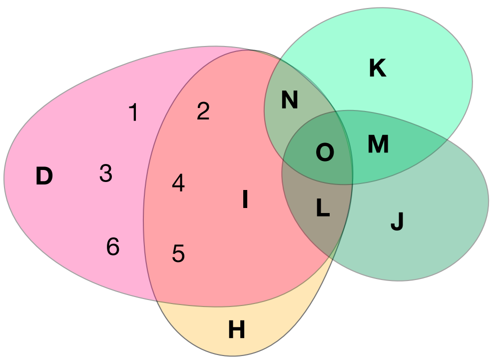


FIGURE 5 KEY	
D	STSE Currents (currents 1 - 6)
1	Application and Design
2	Historical
3	Logical Reasoning
4	Value-Centred
5	Socio-cultural
6	Socio-Ecojustice
H	NS CAPS
I	STSE Currents that appear in NS CAPS (currents 2, 4, 5)
J	Teacher beliefs, values and identity
K	Teacher practices
L	Influence of South African society on NS CAPS
M	Influence of teacher beliefs, values and identity on practices
N	Influence of NS CAPS on teacher practices
O	STUDY FOCUS: Intersection of H, J and K

Figure 5: A conceptual framework showing how science and society themes in the NS CAPS will be evaluated (sub-section of Figure 1)

The focus of this study was to investigate the domain marked 'O' in Figure 5. This domain shows the intersection between domain 'H' (the NS CAPS), domain 'J' (teacher beliefs, values and identity), and domain 'K' (teacher practices). In answering the two research questions of this study, domain 'O' is explored.

5.2.1 Grade 9 NS teachers understanding and valuing of science and society themes as outlined in the NS CAPS

The following discussion addresses the first research question:

> "How do Grade 9 Natural Sciences teachers understand and value science and society themes as outlined in the Natural Sciences Curriculum and Assessment Policy Statement?".

Teacher beliefs about science and science education

Participants felt strongly that students should be able to understand how science is used in the real world. However, comments revealed that participants agreed with this idea predominantly in relation to improving students' understanding of scientific principles and facilitating the development of scientific ways of thinking about the world.

Most participants felt the NS CAPS provided limited opportunity for relevance to students' daily living. Concern was raised about the aims of the curriculum in attempting to be relevant to South African students living in very diverse contexts and communities.

In summary, participants conveyed beliefs in the essential importance of science. In some cases participants expressed ideas about the superiority of scientific knowledge and scientific explanation. Participants generally advocated the process of enculturation of students into scientific ways of thinking and reasoning. Teachers viewed their role in the NS classroom as predominantly to develop the discipline of science and to encourage students to think scientifically as well as to prepare students to take science in the FET band.

Participants also communicated a lack of consideration of the cultural aspects of science. Overall participants expressed the sentiment that the focus of junior science education is the teaching and learning of scientific concepts and principles and that science and society themes and issues are secondary to this primary objective.

5.2.2 Influences of science and society themes on Grade 9 NS teachers' stated practices as outlined in the NS CAPS

The following discussion addresses the second research question:

> "How are Grade 9 Natural Sciences teachers' stated practices influenced by science and society themes as outlined in the Natural Sciences Curriculum and Assessment Policy Statement?".

Influences on participant lesson planning

Three categories of influences on teachers' NS lesson planning were explored. These are the Grade 9 NS CAPS (DBE, 2011), CAPS aligned textbooks and on-line resources.

The greater majority of questionnaire participants reported close adherence to the guidelines of the Grade 9 NS CAPS (DBE, 2011) when planning lessons. Reasons for strict compliance were ensuring all content was covered for the next grade as well as national common papers, pace setting, and complying with department checks and regulations. Many of the participants expressed the opinion that the curriculum was too full and theory laden and felt pressurised to cover all the content within the allocated time frames. Comments indicated that participants' decision-making when planning lessons is dominated and overly managed by the Section 2.9 in the NS CAPS. This section is the work schedule which outlines content and time specifications for each section of work. Participants made use of the work schedule section without much consideration of the principles outlined in the preamble of the NS CAPS (DBE, 2011) which is where science and society ideology predominately appears.

Participants reported relying heavily on textbooks for lesson planning. From the comments provided it can be argued that participants are following sections in prescribed textbooks in a systematic and step-by-step manner. This seems to guide their lesson planning and as such the textbooks largely dictate the outline and sequence of teaching. Some participants suggested that science and society aspects of the NS CAPS are not sufficiently considered in CAPS aligned textbooks.

Approximately 69% of participants reported making use of on-line resources when planning their lessons. However, none of the participants provided examples of where they used the internet to source science and society links or contexts. Examples of the use of on-line resources provided related more directly to the teaching of scientific concepts.

Teacher approaches to science and society

This discussion provided a summary of participants' responses to questionnaire items which related to three of the six STSE currents documented by Pedretti & Nazir (2011) and which are also referred to in the Grade 9 NS CAPS (DBE, 2011).

The data collected shows that almost half of the participants did not make use of historical case studies in their lessons and hence it might be inferred that these teachers are not allowing students opportunity to question the nature of scientific knowledge and its connection to sociocultural contexts. Participants cited that activities associated with the development of values were useful in order to understand the applications of science, but did not indicate that they understood the importance of critical evaluation of the social effects of such applications.

Overall, participants did not communicate a clear understanding of the principles which form science and society in the NS CAPS. Time constraints, deviation from scientific content and limited usefulness for science learning were commonly cited to justify reports about limited science and society practices. Furthermore, participants regularly made statements which communicated their belief in the superiority of science in terms of its explanatory value. In this regard participants showed insensitivity to the cultural barriers students may experience when learning science.

5.3 Research limitations

The following factors provided limitations to this research project.

The sample of participants who completed the questionnaire was relatively small and only drawn from two educational districts in Gauteng. These districts consist predominantly of town schools and hence findings are potentially only representative of these types of schools. As South Africa comprises many different contexts and types of schools this is a potentially limited inquiry.

The questionnaire relied solely on self-reporting by participants. This is a potential source of misrepresentation of the views and practices of teachers which is actually taking place. Furthermore, the items on the questionnaire aimed to inquire about a diverse range of practices and hence potentially created superficiality in the categories and items. It was also observed that the language commonly used in science and society literature was not interpreted in the same way by all participants who were not equally familiar with such frameworks.

5.4 Reflections on the research process

Restrictions on the time frame of the data collection did not allow for me to conduct a pilot study for the questionnaire. I feel that some of the problems of common terms and science and society language use could have been resolved if I had done an initial pilot of the questionnaire.

I was not entirely satisfied with the outcome of the interview process. In hindsight I feel that I did not structure the questions appropriately in such a way as to ensure optimal continuity with the line of questioning set out in the questionnaire. Consequently the data collected from the interviews was not as useful in the research design process as I had hoped it would be.

Despite these challenges I felt that I benefitted immensely as a South African science teacher by undertaking this inquiry. My views on the goals and purposes of science education have drastically shifted and I am now acutely aware of the political and social character of science education. This process has forced me to question my approach to teaching science as well as my reasons for doing so. Consequently I feel I have developed a more comprehensive understanding of, and deep empathy for science students in South Africa. I believe that with this new insight I have the potential to be a more effective and sensitive educator. In this regard I am extremely appreciative of the time donated by participants in helping me undertake this inquiry.

5.5 Recommendations

A new brand of science education which better understands science and society approaches from within the South African context is needed. It is my opinion that such reform is conceivable from within the existing structure of the NCS, albeit that more explicit support is needed for science teachers choosing to become agents of transformation as they attempt implementation.

The potential for South African science teachers to become powerful agents of transformation thus needs to be explored. Speaking of Fensham's (2002) term “educo-politics” Aikenhead (2010) argues that, "all science teachers are constantly engaged in ‘educo-politics'” (Aikenhead, 2010:615). In this study I attempted to uncover some of the socially critical aspects of science and society related themes.

It is proposed that a more critical and deliberate effort be undertaken in promoting adequate teachers’ conceptualisation of the science and society approach to science teaching. This would necessarily need to take into consideration the argument for science education which promotes the development of activism in efforts to represent critical local relevance of the learning of science.

A major factor in such endeavours is to consider the nature of science teacher training as "teacher education programs can play a critical role in helping prospective teachers understand and teach about STSE education and so address the theory/practice gap" (Pedretti, Bencze, Hewitt, Romkey, & Jivraj, 2008:943). Mansour (2009) echoes this sentiment by arguing for a teacher training program which initiates teachers into a science and society orientation as opposed to the traditional approach to science education. In this regard "STS teaching requires new models for pre-and in-service teacher education" (Mansour, 2009:11).

Mansour (2009) also suggests that without adequate support and teacher net-working, the incorporation of science and society teaching is an impossible task. Teachers need opportunities to develop their own values and consequently methods in undertaking science and society teaching. Support networks are therefore vital in this endeavour.

There is consolation to be found in Noddings (1998) argument that, “students and teachers are not mere pawns in a giant game over which they have no control” (Noddings, 1998:510). The fundamental role played by the science teacher when implementing curricula objectives (Steele, 2013:24) is a key consideration in this study. It is important for all South Africans, and especially science teachers, to take part in critical dialogue which questions “whether education is about social reproduction or about enabling social transformation” (Jickling & Wals, 2008:8).

5.6 Suggestions for future research

Investigations into the officially prescribed textbooks needs to be undertaken. Science and society themes in these texts need to critically evaluated. Since teachers rely heavily on textbooks it is important to determine the ways in which textbooks are presenting science and society issues.

The effects and consequences of the prescriptive elements and nature of the NS CAPS (DBE, 2011) need to be critically evaluated. Research reports that although curriculum reform in South Africa was intended to empower teachers in their decision-making about what and how to teach, over-reliance on work schedules and Learning Support Materials (LSMs) results in the constriction of teacher agency (Stoffels, 2008). Such tendencies were observed in this study and hence it is suggested that this aspect of teacher agency be further explored.

5.7 Conclusions

As opposed to the uncontested position which dominates science education, a new focus which emphasises the humanistic aspects of such education is required. As such, science education reforms should emphasise notions like those proposed by Pedretti & Nazir (2011) in their discussion of the STSE currents. Teachers operating from within this framework are fundamentally critical of the aims, purposes and outcomes of science education with respect to the extent to which it holds transformative potential for individual students. This approach to science education, particularly in the lower secondary level classes, could ensure that South African students are afforded a culturally sensitive space in which to develop critical awareness about STSE related factors which impact their personal decision-making abilities, as well as affect the well-being of the communities (both human and of a natural order) in which they live. This could have positive consequences for the effective education of critical and active South African citizens who are not excluded from culturally specific bodies of knowledge such as those seen in the traditionally western science discipline.

Contradictions can be observed in the process of curriculum reform in South Africa. Initially OBE as a design, allowed for the individualisation and contextual adaptation of content and curricula objectives. Currently, Grade 9 NS CAPS (DBE, 2011) has become highly prescriptive with little room for innovation. From within the NCS framework, opportunity still remains for individual science teachers to promote science and society approaches which address such issues. However, due to the phrasing of certain ideas relating to science and society seen in the current Grade 9 NS CAPS, the extent to which, as well as the ways in which, science teachers make use of such approaches is left to the initiative of individual teachers without any further accountability.

In a report reviewing educational progress in the first ten years of democratic governance, it was concluded that, “the global environment has proven a difficult one for democracy building and the privileging of aggressive educational redress” and that, “the values most dominant in the global economy emphasise competition over cooperation, detachment over compassion, the private over the public, the individual over the social” (Nelson Mandela Foundation, 2004:35). Again, highlighting necessarily competing ideology, this points to the possibility that the new democratic government, struggling with global economic pressures and competition in markets, may have perhaps exchanged some of the transformative power of the NCS for the opportunity to participate in the global economy. Noddings (2005) argues that, “we cannot ignore our children - their purposes, anxieties, and relationships - in the service of making them more competent in academic skills” (Noddings, 2005:35).

I propose that schools should be aiming at helping students develop social and emotional thinking skills and frameworks for understanding and meaning-making, instead of focusing solely on cognitive academic curriculum consumption. This would necessarily challenge the "notion that matters of the mind are superior to matters of the body and spirit” (Hansen 2008:9).

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APPENDIX 1 **Informed Consent Form**

Science Teacher Informed Consent

Karryn Austen
Wits School of Education
karryn.austen@gmail.com

January to April 2017
Student Number: 9910681R
Protocol Number: 2017ECE060MR

Dear Science Teacher,

Please fill in and return the reply slip below indicating your willingness to be a participant in my voluntary research project titled:

SCIENCE TEACHERS' CONCEPTUALISATION OF SPECIFIC AIM 3 IN THE GRADE 9 NATURAL SCIENCES CAPS AND ASSOCIATED PEDAGOGICAL PRACTICES

I, ______________________________ (please print your name and surname) give my consent for the following:

Permission for QUESTIONNAIRE to be administered:
I agree to fill in a question and answer sheet for this study. YES / NO *(please circle)*

Permission to be INTERVIEWED:
I would like to be interviewed for this study. YES / NO *(please circle)*

I know that I can stop the interview at any time and don't have to answer all the questions asked. YES / NO *(please circle)*

Permission to be AUDIOTAPED:
I agree to be audiotaped during the interview. YES / NO *(please circle)*

I know that the audiotapes will be used for this project only. YES / NO *(please circle)*

I understand that:
- my name and information will be kept confidential and safe and that my name and the name of my school will not be revealed.
- I do not have to answer every question and can withdraw from the study at any time.
- I can ask not to be audiotaped.
- all the data collected during this study will be destroyed within 3-5 years after completion of my project.

Sign ______________________ Date ______________

APPENDIX 2 Letter to Teacher

Science and Society
Teacher Survey
K. Austen
Wits School of Education
E-Mail: karryn.austen@gmail.com

January to April 2017
Student Number: 9910681R
Protocol Number: 2017ECE060MR

Dear Natural Sciences Teacher

I am currently completing a Masters of Science Education at the University of the Witwatersrand, and specifically, I am researching Specific Aim 3 in the Natural Sciences CAPS, and how teachers are choosing to work with this Specific Aim in their Grade 9 Natural Sciences classes. The Specific Aim 3 relates to Science and Society themes, and is becoming increasingly important in our South African junior science classes.

I would like to respectfully request your assistance with my research by completing the attached questionnaire and informed consent documents. The questionnaire should take a participant approximately 20 minutes to complete. No classroom observation is needed for this research, and should the participant be willing, three teachers from all participants will be selected to complete an interview, which will also be done after school hours. I can assure you that teaching time will not be impacted or affected in any way.

Necessary consent has been given by the Gauteng Department of Education (see permission letter enclosed).

Each participant teacher needs to complete both the questionnaire and the informed consent document. Should your school be willing to participate in my research project, I would request that questionnaires be completed and then for me to be notified via email when completed questionnaires and informed consent documents can be collected.

Please be assured that all interactions with participants and your institution will be informed by the most sincere appreciation and respect, and strict confidentially will be upheld at all times. Participation in this research is entirely voluntary

Your assistance in this regard would be greatly appreciated, as there is exciting work to be done around Specific Aim 3.

Kind regards,

Karryn Austen
karryn.austen@gmail.com
011 472 3885

APPENDIX 3 Letter to HOD

Science and Society
Teacher Survey
K. Austen
Wits School of Education
E-Mail: karryn.austen@gmail.com

January to April 2017
Student Number: 9910681R
Protocol Number: 2017ECE060MR

Dear Head of Science Department

I am currently completing a Masters of Science Education at the University of the Witwatersrand, and specifically, I am researching Specific Aim 3 in the Natural Sciences CAPS, and how teachers are choosing to work with this Specific Aim in their Grade 9 Natural Sciences classes. The Specific Aim 3 relates to Science and Society themes, and is becoming increasingly important in our South African junior science classes.

I would like to respectfully request that your science teacher(s) assist me in my research by completing the attached questionnaire and informed consent documents. The questionnaire should take a participant approximately 20 minutes to complete. No classroom observation is needed for this research, and should the participant be willing, three teachers from all participants will be selected to complete an interview, which will also be done after school hours. I can assure you that teaching time will not be impacted or affected in any way.

Necessary consent has been given by the Gauteng Department of Education (see permission letter enclosed).

Each participant teacher needs to complete both the questionnaire and the informed consent document. Should your school be willing to participate in my research project, I would request that questionnaires be completed and then for me to be notified via email when completed questionnaires and informed consent documents can be collected.

Please be assured that all interactions with participants and your institution will be informed by the most sincere appreciation and respect, and strict confidentially will be upheld at all times. Participation in this research is entirely voluntary

Your assistance in this regard would be greatly appreciated, as there is exciting work to be done around Specific Aim 3.

Kind regards,

Karryn Austen
karryn.austen@gmail.com
011 472 3885

APPENDIX 4 Letter to Principal

Science and Society
Teacher Survey
K. Austen
Wits School of Education
E-Mail: karryn.austen@gmail.com

January to April 2017

Student Number: 9910681R

Protocol Number: 2017ECE060MR

Dear Principal

I am currently completing a Masters of Science Education at the University of the Witwatersrand, and specifically, I am researching Specific Aim 3 in the Natural Sciences CAPS, and how teachers are choosing to work with this Specific Aim in their Grade 9 Natural Sciences classes. The Specific Aim 3 relates to Science and Society themes, and is becoming increasingly important in our South African junior science classes.

I would like to respectfully request that your science teacher(s) assist me in my research by completing the attached questionnaire and informed consent documents. The questionnaire should take a participant approximately 20 minutes to complete. No classroom observation is needed for this research, and should the participant be willing, three teachers from all participants will be selected to complete an interview, which will also be done after school hours. I can assure you that teaching time will not be impacted or affected in any way.

Necessary consent has been given by the Gauteng Department of Education (see permission letter enclosed).

Each participant teacher needs to complete both the questionnaire and the informed consent document. Should your school be willing to participate in my research project, I would request that questionnaires be completed and then for me to be notified via email when completed questionnaires and informed consent documents can be collected.

Please be assured that all interactions with participants and your institution will be informed by the most sincere appreciation and respect, and strict confidentially will be upheld at all times. Participation in this research is entirely voluntary

Your assistance in this regard would be greatly appreciated, as there is exciting work to be done around Specific Aim 3.

Kind regards,

Karryn Austen
karryn.austen@gmail.com
011 472 3885

APPENDIX 5 Questionnaire

Natural Sciences Teacher Questionnaire | Science and Society

SECTION 1 Participant General Information

Please place a "X" over your selection for each question below, or where required fill in the space.										
1.1	Gender	Male	Female	1.2	Race	Black	Coloured	Indian	White	Other
1.3	Home Language			1.4	Age Group (yrs)	< 25	26 - 35	36 - 45	46 - 55	56 <
1.5	School Area			1.6	Highest level of formal education completed	H Dip Ed	B Ed	BSc with PGCE	Post-Grad	
1.7	Teaching experience in total (yrs)			1.8	Natural Sciences teaching experience (yrs)					
1.9	Hours of NS "in-service" training you received provided by DoE?			1.10	Hours of NS "in-service" training you received provided by your school?					
1.11	Do you intend to study further?	Yes	No	1.12	Did you intend to teach NS at the start of your career/ studies?				Yes	No
1.13	If you answered "No" to 1.12, please provide more information.									

SECTION 2 Natural Sciences Teaching Strategies of Participant

The table below lists various teaching strategies. Please place a "X" in the block of your selection for each statement to indicate the frequency with which you make use of each teaching strategy, or where required fill in the space					
2.1	I require my NS students to complete a research project on global warming and/ or greenhouse gases.	Strongly Agree	Agree	Disagree	Strongly Disagree
2.2	I use group work and group discussions in each of my NS lessons.	Strongly Agree	Agree	Disagree	Strongly Disagree
2.3	I use formal debates in my NS lessons to encourage students to be critical of the everyday products they consume.	Strongly Agree	Agree	Disagree	Strongly Disagree
2.4	Please comment on your response to 2.3 (please provide details if appropriate).				
2.5	I require my students to complete projects in which they design and test basic technology using scientific principles.	Strongly Agree	Agree	Disagree	Strongly Disagree
2.6	Please comment on your response to 2.5 (please provide details about the projects you might use).				
2.7	The use of simulations and/ or animations are a regular part of my NS lessons.	Strongly Agree	Agree	Disagree	Strongly Disagree
2.8	I make use of social issues which relate to science in teaching my NS classes.	Strongly Agree	Agree	Disagree	Strongly Disagree
2.9	Please comment on your response to 2.8 (please specify which types of social contexts you might use).				

SECTION 2 Natural Sciences Teaching Strategies of Participant

The table below lists various teaching strategies. Please place a "X" in the block of your selection for each statement to indicate the frequency with which you make use of each teaching strategy, or where required fill in the space					
2.10	I encourage my students to develop their values about social issues related to science in South Africa.	Strongly Agree	Agree	Disagree	Strongly Disagree
2.11	Please comment on your response to 2.10.				
2.12	I make use of case studies showing the history of science in my NS lessons.	Strongly Agree	Agree	Disagree	Strongly Disagree
2.13	I encourage my NS students to undertake action plans, such as litter clean-up, in my local school setting.	Strongly Agree	Agree	Disagree	Strongly Disagree
2.14	Please comment on your response to 2.13.				
2.15	Please comment on any other teaching strategies which you frequently make use of.				

SECTION 3 Natural Sciences Lesson Planning by Participant

The table below lists various planning strategies. Please place a "X" in the block of your selection for each statement to indicate the main influences on your lesson planning, or where required fill in the space.					
3.1	I carefully follow the guidelines in the Gr 9 NS CAPS document when planning my lessons.	Strongly Agree	Agree	Disagree	Strongly Disagree
3.2	Please comment on your response to 3.1.				
3.3	I rely primarily on textbooks to determine what I teach.	Strongly Agree	Agree	Disagree	Strongly Disagree
3.4	Please comment on your response to 3.3 (please include the name of the textbooks prescribed to your students).				

SECTION 3 Natural Sciences Lesson Planning by Participant

The table below lists various planning strategies. Please place a "X" in the block of your selection for each statement to indicate the main influences on your lesson planning, or where required fill in the space.					
3.5	I regularly make use of on-line resources to help me plan my NS lessons.	Strongly Agree	Agree	Disagree	Strongly Disagree
3.6	Please comment on your response to 3.5.				
3.7	Please comment on any other influences on your planning which you frequently make use of.				

SECTION 4 Participant Views about Science and Science Education

Please place a "X" in the block of your selection for each statement to indicate your views on science and science education in South Africa, or where required fill in the space.					
4.1	It is important for Gr 9 NS students to understand how science is used in the real world.	Strongly Agree	Agree	Disagree	Strongly Disagree
4.2	It is important for Gr 9 NS students to remember formulas and procedures.	Strongly Agree	Agree	Disagree	Strongly Disagree
4.3	Science & technology offer a great deal of help in resolving social problems such as poverty, crime & unemployment.	Strongly Agree	Agree	Disagree	Strongly Disagree
4.4	Science and technology can fix environmental problems in the future.	Strongly Agree	Agree	Disagree	Strongly Disagree
4.5	The Gr 9 NS CAPS specifications provide students with opportunities to connect science they learn in school to experiences outside of the classroom	Strongly Agree	Agree	Disagree	Strongly Disagree
4.6	Technological developments can be controlled by South African citizens.	Strongly Agree	Agree	Disagree	Strongly Disagree
4.7	Gr 9 NS is mostly important in preparing students to be able to take science in the FET band.	Strongly Agree	Agree	Disagree	Strongly Disagree
4.8	Students should be encouraged to see science as just one of the many ways of knowing about the natural world.	Strongly Agree	Agree	Disagree	Strongly Disagree
4.9	Please comment on your response to 4.8.				

SECTION 4 Participant Views about Science and Science Education

Please place a "X" in the block of your selection for each statement to indicate your views on science and science education in South Africa, or where required fill in the space.					
4.10	Students choose to study science after Gr 9 to ensure they have a good job that pays well when they graduate.	Strongly Agree	Agree	Disagree	Strongly Disagree
4.11	Traditional African Indigenous Knowledge has an important part to play in South African science education.	Strongly Agree	Agree	Disagree	Strongly Disagree
4.12	Please comment on your response to 4.11.				
4.13	Please comment on any other views you have concerning the relationship between science and society in South African science education, specifically those outlined by Specific Aim 3 in the NS CAPS.				

Thank you for your participation!

Please remember to complete the informed consent document as well.

APPENDIX 6 **Interview Schedule**

Science and Society Investigation

Interview Schedule

1. Introduction and thanks

2. Overview of Specific Aim 3 in relation to research process
   Refer participants to the following excerpt: NS CAPS (DBE, 2011:10)

   SPECIFIC AIM 3: 'understanding the uses of science '

   Learners should understand the uses of natural sciences and indigenous knowledge in society and the environment.

   Science learnt at school should produce learners who understand that school science can be relevant to everyday life. Issues such as improving water quality, growing food without damaging the land and building energy-efficient houses are examples of applications.

   An appreciation of the history of scientific discoveries, and their relationship to indigenous knowledge and different world views, enriches our understanding of the connections between Science and Society.

3. General participant information
   a) What motivated you to become science teacher?
   b) Provide 5 adjectives ton describe you as a science teacher.

4. Views on science education
   a) Refer participants to the following excerpt: NS CAPS (DBE, 2011:8-9):

   Careful selection of content, and use of a variety of approaches to teaching and learning Science, should promote understanding of:

   - Science as a discipline that sustains enjoyment and curiosity about the world and natural phenomena

- the history of Science and the relationship between Natural Sciences and other subjects
- the different cultural contexts in which indigenous knowledge systems have developed
- the contribution of Science to social justice and societal development
- the need for using scientific knowledge responsibly in the interest of ourselves, of society and the environment
- the practical and ethical consequences of decisions based on Science.

  Natural Sciences at the Senior Phase level lays the basis of further studies in more specific Science disciplines, such as Life Sciences, Physical Sciences, Earth Sciences or Agricultural Sciences. It prepares learners for active participation in a democratic society that values human rights and promotes responsibility towards the environment. Natural Sciences can also prepare learners for economic activity and self-expression.

b) What do you feel the goals of NS education are?

c) What do you see your role as being in the NS classroom?

d) Do you feel the NS CAPS (DBE, 2011) allows for relevancy and interest for students?

5. Views on the Nature of Science (NOS)

a) Refer participants to the following excerpt: NS CAPS (DBE, 2011:8):

> The science knowledge we teach at school is not in doubt – most of it has been tested and known since the 1800s

b) What are your views on this statement?

6. Views on IKS

   a) Refer participants to the following excerpt: NS CAPS (DBE, 2011:8):

> Our forebears would not have survived if they had not been able to learn about the natural world they depended on. They made careful observations, recognised regular patterns in seasons, the life cycles of plants, and the behaviour of animals.
> They had theories about cause and effect too, and understood many of the relationships in the environment where they lived. These sets of knowledge, each woven into the history and place of people, are known as indigenous knowledge systems.
> Indigenous knowledge includes knowledge about agriculture and food production, pastoral practices and animal production, forestry, plant classification, medicinal plants, management of biodiversity, food preservation, management of soil and water, iron smelting, brewing, making dwellings and understanding astronomy. As society changes, some of that knowledge is being lost. People such as biologists, pharmacists and archaeologists are seeking it out and writing it down before it is gone.

   b) What are your views on teaching IKS in your NS lessons?

7. Refer to table of teaching adjectives in the six STSE currents formulated by Pedretti & Nazir (2011)

   a) select three you often make use of

   b) select three you never make use of

8. Please speak about your interest in science and society in South Africa and how you use science and society in your NS lessons or school activities.

APPENDIX 7 Ethics Clearance

Wits School of Education

WITS UNIVERSITY

27 St Andrews Road, Parktown, Johannesburg, 2193 Private Bag 3, Wits 2050, South Africa. Tel: +27 11 717-3064
Fax: +27 11 717-3100 E-mail: enquiries@educ.wits.ac.za Website: www.wits.ac.za

11 January 2018

Student Number: 9910681R

Protocol Number: 2017ECE060MR

Dear Karryn Austen

Application for Ethics Clearance: Master of Science

Thank you very much for your ethics application. The Ethics Committee in Education of the Faculty of Humanities, acting on behalf of the Senate has considered your application for ethics clearance for your proposal entitled:

Natural Sciences teachers' conceptualisation of 'Science in Society' in South African curriculum documents.

The committee recently met and I am pleased to inform you that **clearance was granted**. However, there were a few small issues which the committee would appreciate you attending to before embarking on your research.

The following comments were made:

- The word "natural" is repeated in the title of the application.
- Section 7: Please indicate that the data will be stored securely at the WSoE in your supervisor's office.

Please use the above protocol number in all correspondence to the relevant research parties (schools, parents, learners etc.) and include it in your research report or project on the title page.

The Protocol Number above should be submitted to the Graduate Studies in Education Committee upon submission of your final research report.

All the best with your research project.

Yours sincerely,

Wits School of Education

011 717-3416

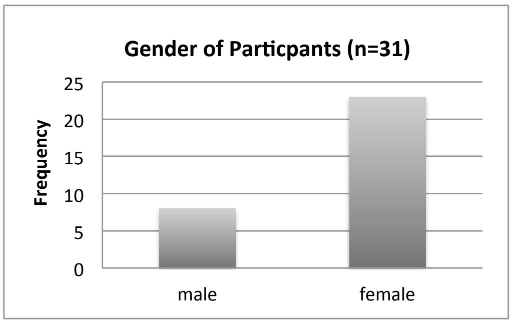
Cc Supervisor: Dr Megan Doidge

APPENDIX 8 Questionnaire Data Capture

QUESTION 1 Basic Analysis

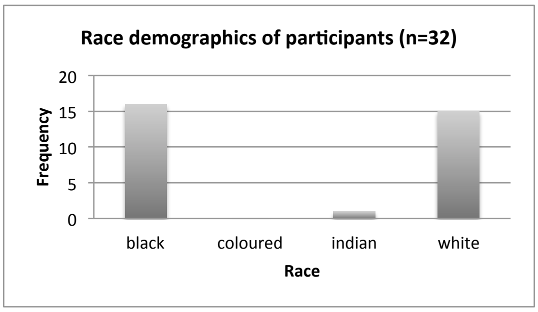
1.1

Gender	F	%
male	8	25,0
female	23	71,9
nr	1	3,1
T	32	100



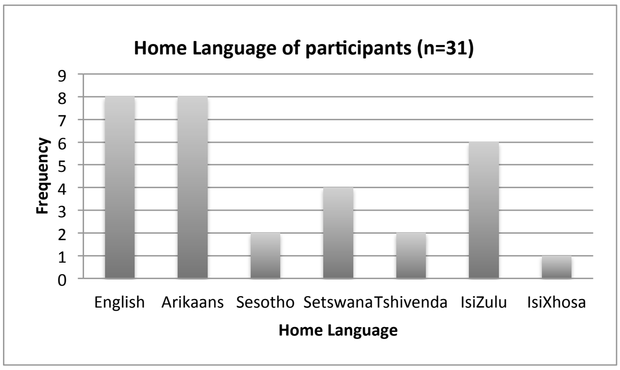
1.2

Race	F	%
black	16	50,0
coloured	0	0,0
indian	1	3,1
white	15	46,9
nr	0	0,0
T	32	100



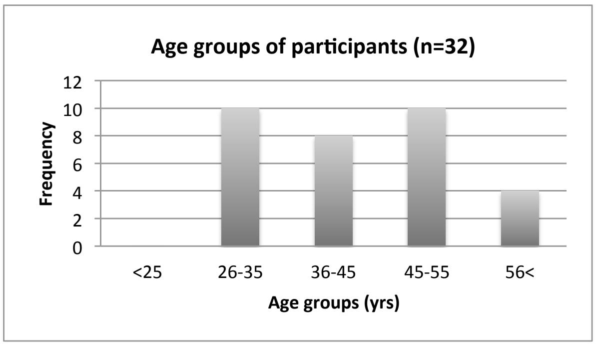
1.3

HL	F	%
English	8	25,0
Arikaans	8	25,0
Sesotho	2	6,3
Setswana	4	12,5
Tshivenda	2	6,3
IsiZulu	6	18,8
IsiXhosa	1	3,1
nr	1	3,1
T	32	100



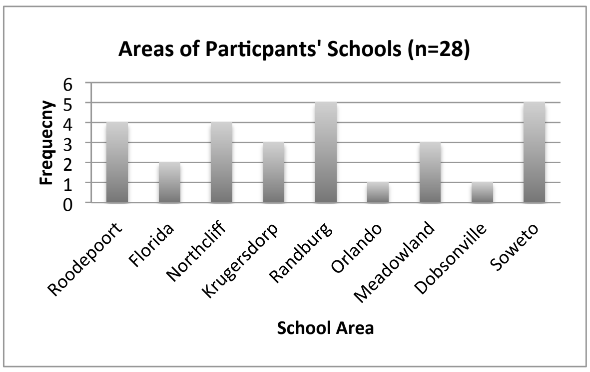
1.4

Age	F	%
<25	0	0
26-35	10	31,3
36-45	8	25,0
45-55	10	31,3
56<	4	12,5
nr	0	0
T	32	100



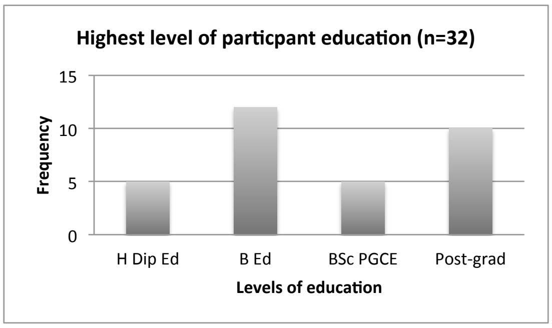
1.5

School Area	F	%
Roodepoort	4	12,5
Florida	2	6,3
Northcliff	4	12,5
Krugersdorp	3	9,4
Randburg	5	15,6
Orlando	1	3,1
Meadowland	3	9,4
Dobsonville	1	3,1
Soweto	5	15,6
nr	4	12,5
T	32	100



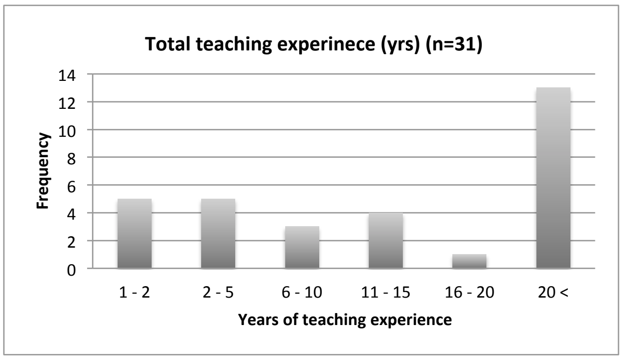
1.6

Education	F	%
H Dip Ed	5	15,6
B Ed	12	37,5
BSc PGCE	5	15,6
Post-grad	10	31,3
nr	0	0,0
T	32	100



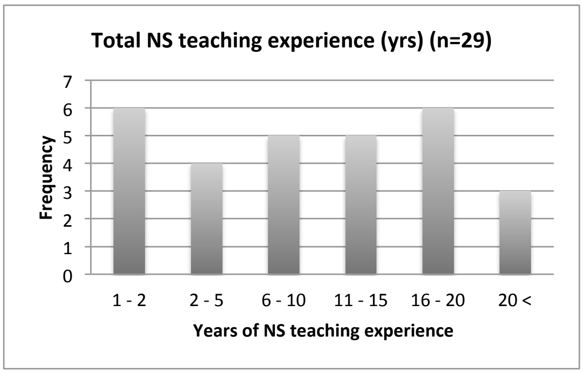
1.7

Total teaching exp (yrs)		%
1 - 2	5	15,6
2 - 5	5	15,6
6 - 10	3	9,4
11 - 15	4	12,5
16 - 20	1	3,1
20 <	13	40,6
nr	1	3,1
T	32	100



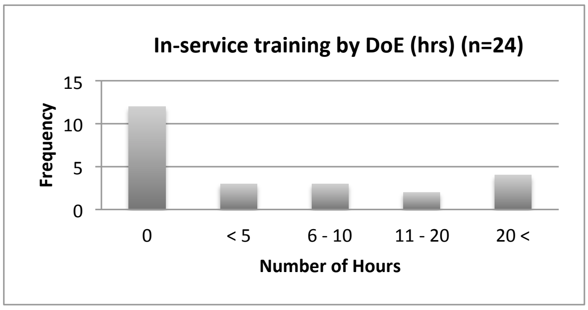
1.8

NS teaching exp (yrs)		%
1 - 2	6	18,8
2 - 5	4	12,5
6 - 10	5	15,6
11 - 15	5	15,6
16 - 20	6	18,8
20 <	3	9,4
nr	3	9,4
T	32	100



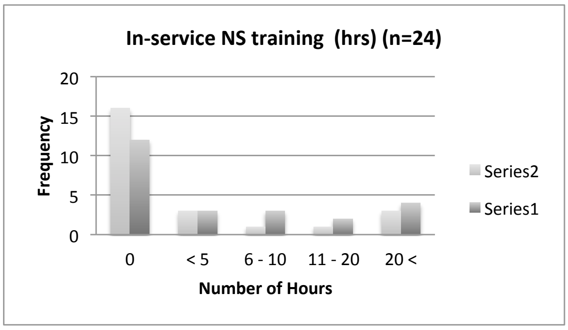
1.9

In-service DoE (hrs)		%
0	12	37,5
< 5	3	9,4
6 - 10	3	9,4
11 - 20	2	6,3
20 <	4	12,5
nr	8	25,0
T	32	100



1.10

In-service School (hrs)		%
0	16	50,0
< 5	3	9,4
6 - 10	1	3,1
11 - 20	1	3,1
20 <	3	9,4
nr	8	25,0
T	32	100

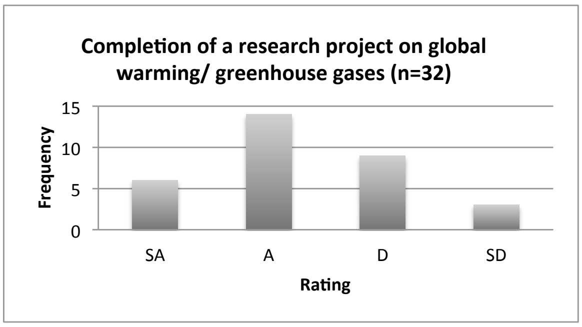


Series 1: DoE, Series 2: SMT

QUESTION 2 Basic Analysis

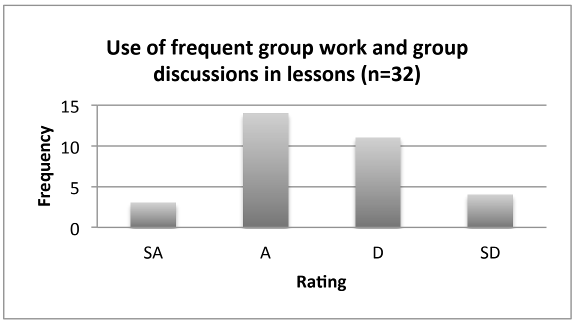
2.1

Global warm/ gh RP?		%
SA	6	18,8
A	14	43,8
D	9	28,1
SD	3	9,4
nr	0	0,0
T	32	100



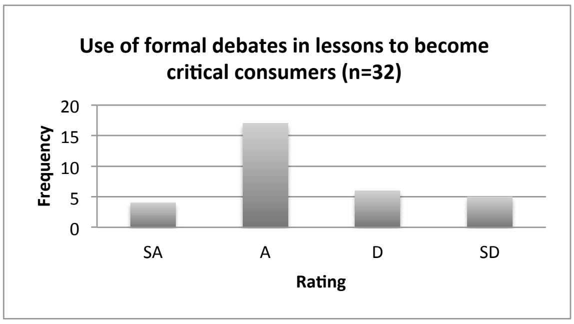
2.2

Group work & discussion?		%
SA	3	9,4
A	14	43,8
D	11	34,4
SD	4	12,5
nr	0	0,0
T	32	100



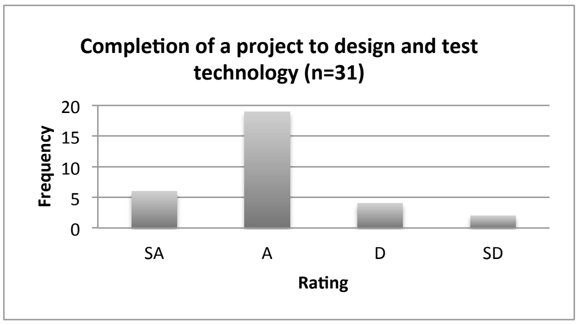
2.3

Form deb for crit consum?		%
SA	4	12,5
A	17	53,1
D	6	18,8
SD	5	15,6
nr	0	0,0
T	32	100



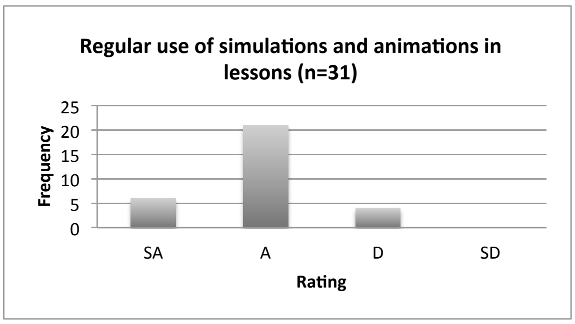
2.5

Design & Test Tech		%
SA	6	18,8
A	19	59,4
D	4	12,5
SD	2	6,3
nr	1	3,1
T	32	100

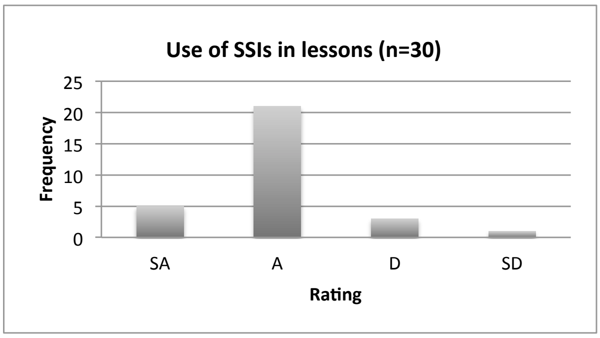


2.7

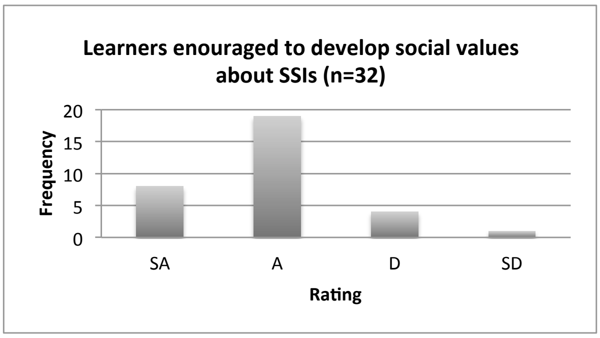
Sim/ Ani used reg?		%
SA	6	18,8
A	21	65,6
D	4	12,5
SD	0	0,0
nr	1	3,1
T	32	100



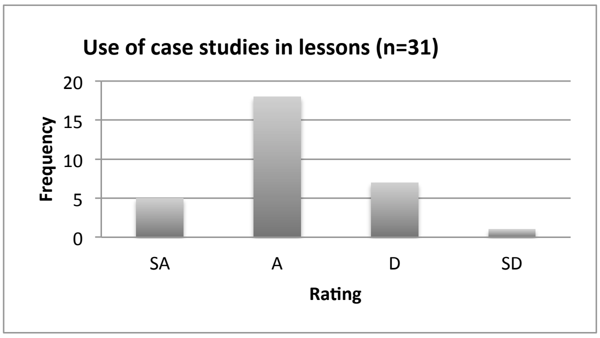
2.8		
	Use SSIs?	%
SA	5	15,6
A	21	65,6
D	3	9,4
SD	1	3,1
nr	2	6,3
T	32	100

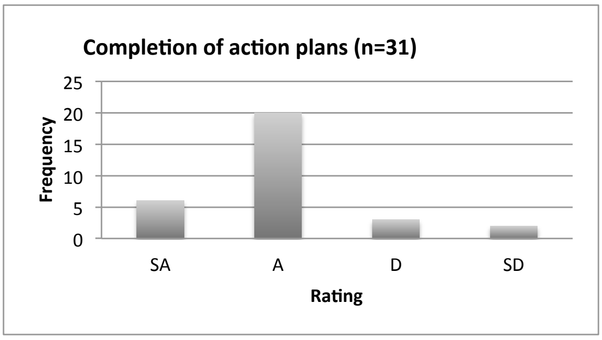


2.10		
	Encourage L to dev values?	%
SA	8	25,0
A	19	59,4
D	4	12,5
SD	1	3,1
nr	0	0,0
T	32	100



2.12		
	Use case studies?	%
SA	5	9,4
A	18	43,8
D	7	34,4
SD	1	12,5
nr	1	0,0
T	32	100,1





2.13		
	Action plans?	%
SA	6	18,8
A	20	62,5
D	3	9,4
SD	2	6,3
nr	1	3,1
T	32	100

P	2.4	2.6	2.9	2.11	2.14	2.15
1	Eg. the use of electrical appliances; is it cost effective. Eg. acids; the effect of gas cold-drinks on the learners' bodies.	Our research project is about acids and bases.	Eg. the building of houses in light of the energy crisis.	Science is everywhere, eg. fuel is made up of elements, power, and structures.	Recycling in class (paper) and recycling at home (all waste).	Quizzes (learners enjoy the competition) and Questions and Answers (to keep their attention to learn).
2	Time is limited. I'm not a language teacher, thus I don't intend to do formal debates. Some children lose interest during debates and become bored.	I do experiments over a couple of weeks on the effect of a few drinks (tea, coffee, coke) on teeth. We use eggshells to represent the teeth as it contains some of the same chemicals. They have to weigh it, look for chemical and physical changes.	Issues on global warming, temperature and climate change, earthquakes, corrosion	No comment made.	We do paper recycling to save the trees and have a smaller carbon footprint.	No comment made.
3	Pair work is used very often as it is easier to ensure all students participate. Formal debates are used from time to time. However, teaching the ethics around formal debating often takes up a bit of time as debates can easily result in argument if ethics aren't enforced.	This would be fantastic. However, it is a rush every single term to finish the syllabus, complete administrative tasks and to convince learners to actively participate in a subject not all of them have an interest in is pushing the emotional and physical capacity of educators.	Eg. body systems: Obesity is a societal issue. We look at food choices of learners, the amount of sugar in those foods and understanding a label on packaging. Healthy life choices start early on in life.	No comment made.	No comment made.	No comment made.
4	We talk about energy drinks, what they are intended for and how dangerous they can be. Also debate over what is clean and dirty water.	We get them to do research on certain mining materials, certain factors on their chosen minerals and how the mine effects the environment around it.	Poaching, global warming and climate change. I debate whether they agree with these factors and to think out the box on solutions or improvements that could be made.	No comment made.	No comment made.	No comment made.
5	Debates encourage learners to think and apply the scientific principles. They need to understand their surrounding environment.	No comment made.	They need to understand what they have, others don't have and are forced to do things that are not environmentally friendly.	No comment made.	No comment made.	No comment made.
6	Attempt to apply formal work to scenarios they can relate to.	Research tasks and inventive methods. Design new patents.	No comment made.	No comment made.	Encourage them to be more observant with regards to Science around them in everyday life.	Lessons are interactive. Encourage questions and broad thinking.
7	I do encourage debate and discussions. However, this occurs informally when learners have a question or I add further information not required by the syllabus.	They do projects using scientific principles, though the choice of testing is open to their interest. Some projects have tested solar cookers, windmills, solar panels and grey water.	Issues around clean water, usage of electricity, pollutants in the atmosphere - areas relating to urban issues about which our learners are more in touch with.	In teaching about use of technology in the home e.g.. electricity, I discuss safe and appropriate use. Any environmental science issues I mention in my lessons for open discussion on the appropriate responses individuals should have or consider.	I am in charge of the school environmental club where I encourage specifically learner environmental project ideas which they must organize and we support. This has been quite successful e.g. Black Eagle Project which we raised funds for.	Use of YouTube videos of practical issues. Use of power point presentations with pictures.

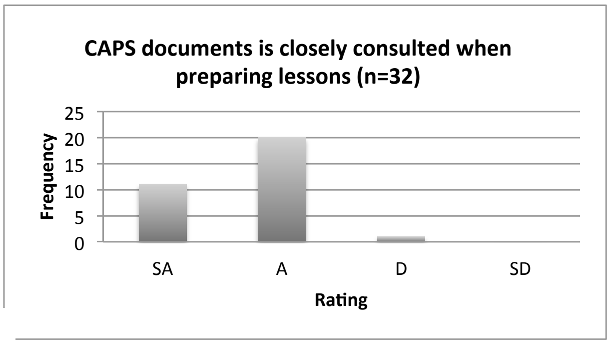
8	There is no time for such debate.	Every year Grade 9 learners are to complete a research investigative project. They must make use of the scientific method. It must be quantitative.	No comment made.	I don't know enough about the social issues.	The school has a dedicated time for cleaning litter and recycling program.	No comment made.
9	Time does not allow debates to get the required knowledge.	They are doing a research project individually or in pairs on their own topic. We lead them with a proposal and applying the scientific method.	When doing electricity we will talk about the impact of load shedding for example.	This is a fact driven subject, so we stay on the topic at hand.	My personal focus is more on the seniors. We have an environmental club at school where they can get involved.	iPad and google.
10	We discuss who if for and who is against certain issues like using steroids.	When a students designs and tests his/ her own work, it makes them enjoy it more and learn from it and realize how it fits into the real world.	I use the issue of rhino poaching, global warming, happenings in parliament etc.	When we have debates on certain topics, learners are forced to make up their own minds on something and to develop their own opinions.	Learners learn to be more aware of what is going on around them and how their behavior affects their society and future.	No comment made.
11	Discuss food and drinks (especially containing lots of sugar and caffeine).	When they design their own experiments they learn and remember better.	We discuss issues regarding health - what causes high cholesterol etc. These make Science relevant.	Learners need to think about issues and take responsibility regarding opinions.	They learn to respect their surroundings and be proud of where they live/ go to school.	Practicals are essential - learners need to experience and feel the organs etc.
12	No time, a very full (much too long) curriculum!!	Keep it very simple.	Making the subject relevant to everyday life!	There must be a strong connection between content and everyday life. Eg. What does smoking do to your body and those around you. Eg. Stealing electricity (how does it effect South Africa and not just yourself).	Saving water and electricity, starting in your house! Get a positive attitude, save our planet!	Showing content in a practical way. Eg. sheep lungs, heart, kidneys and chicken skeleton showing cartilage, tendons and ligaments.
13	Often helps learners to formalize and process their thoughts if we debate topics.	In doing this they are able to work through the scientific process.	I relate to everyday issues such as improving water qualities and growing food sustainably.	Appreciate what they have around them.	We do surveys on litter, water usage etc. They make posters ti communicate with other learners.	Use of videos to show learners social issues relating to Science.
14	I encourage informal discussions. Time does not allow for formal debates to happen.	We teach the Biology and Science as two subjects so doesn't fir into my sections.	Only use where and when applicable.	Talk about the moral ethics of things like stem cells and genetic engineering.	We don't do this. Time and numbers of learners don't allow is to fit this kind of activity in.	We strongly encourage practical work and try where possible to fit it into the lesson plans. Microscope work is also a big part of our learning.

15	I teach the Life Sciences component only. Two lessons per week is little contact time for including debates. Learners also sadly not very mature and with large classes, time constraints is an issues. I do allow question and answer sessions.	We conduct a Science Fair.	Consequences of drug abuse, poor diet, lack of exercise, especially linked to different financial levels. Pollution issues and impacts on resources.	I attempt to be passionate and instill a sense of wonder as well as responsibility. Some learners respond. Many are still quite young and not very interested.	I'd like to. Time constraints affect this and learners aren't well motivated for self care let alone environmental care.	No comment made.
16	The annual teaching plan is broad. A lot of time is spent on explaining concepts so that the learners can understand the practical side of the theory. Time allocated for NS is 4,5 hours per week.	Learners asked to do Science Fair and Eskom Expo which relates to basic technology.	The sum of social issues extend to debates which leads to a lot of deviation from the content. Again, time constraints is a problem.	The values instill a sense of responsibility and encourage the learners to love the subject and take interest in some of the topics they didn't like.	The school has provided recycle bins for paper, plastic and bottles. Learners learn about biodegradable objects (plastics) etc. They need to practice what's being taught also on pollution.	No comment made.
17	It helps learners to link concepts to everyday life and helps them to understand scientific concepts better through application.	Applying scientific principles is vital for learners as it demonstrates understanding. For example, a science investigation is given to kids where they can research and draw on an experiment to test relevant theories by using the correct scientific reporting techniques e.g. a hypothesis.	I have introduced Science social issues into my teaching by giving kids daily science news which links the latest inventions and findings to my lesson. This is a reminder to learners as to why they are taking this relevant subject as well as to motivate them.	I believe that it is very important to inform learners about social issues such as ethical procedures but it is even more important to allow them to create their own values so that they can develop respect and understanding. In my class I create lesson plans which allow me the flexibility to talk to learners and debate social issues in Science. I also encourage them to join UNISA Empowerment Programs which debate science issues.	I believe that it is important to teach learners about action plans as well as allow them to demonstrate how to solve a problem in a safe environment. Schools are safe environments that help learners develop scientific skills and apply them.	Science series e.g. Cosmos. PHET simulations. NASA app. Science Daily (website). Quetz Magazine.
18	I provide the question and encourage "for" and "against" discussion.	No comment made.	The subject matter relates to all students. There is a need in Biology to make them aware of other individuals' circumstances. Holistic teaching.	No comment made.	Need to take responsibility for actions.	Lots of questions and answers.
19	Discussion of life-style disorder eg. Obesity and diabetes-interplrelations of food labels, research on energy costs, shortages and impact on the environment.	Solar cooker, solar geyser, energy conservation projects	Poverty and unemployment, service delivery protests	Values developed and shaped by knowledge of social issues will have greater impact on consumption patterns.	Recycle and re-use project	Practicals, presentations, field trips.
20	Certain topics require discussio to clear misconceptions.	Scientific language is to be used and practiced. Practical work helps in them understanding and see prcatically what they are learning.	Its always important when you teach to relate and give practical examples in order for learners to link what they are learning with reality.	Learners do no know how to link science with their everyday life and its important for them to be shown.	Learners knowing the importance of recycling etc.	No comment made.
21	Learners will consume time, because NS needs and explanation in detail and being wiring on the chalk-board, or showing them the examples of each matter that is being taught.	Scientific method and the variables.	Examples of the household that are being used at home eg. Bleach, sunlight liquid, vinegar, eno	No comment made.	Weekly, every Wednesday after school one class pick up paper in the school yard and also in the classes.	Discovery method, lecture method, question and answer method.

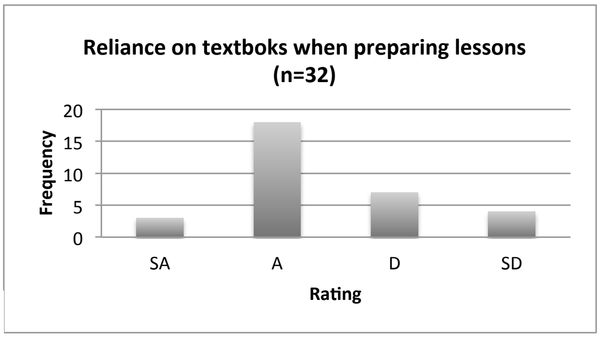
22	Yes, I let learners interact debate about a topic. They argue until they reach an agreement.	I allow creativity of the learners.	I use examples they know quite well. Things they experience everyday.	I corerlate science and society in my teaching.	We collect cans, paper and plastics.	No comment made.
23	Groupwork, sometimes learners understand better from classmates than when studying alone.	No comment made.	No comment made.	No comment made.	No comment made.	No comment made.
24	No comment made.	Electricity	I connect science terms with social issues.	Yes, the students relate science with reality which is happening in our country.	Recycling	Question and answer, discussion
25	I have not encountered any area where I can apply the teaching method of debating, hence I have nottried it. It is worthwhile to encourage learners to do stuch an activity.	An example would be an experiment to demonstrate the relationship between pressure and volume using a syringe.	Mitigating the problme of air pollution by introducing resource efficiency and sustainable development.	It is important for learners to be against certain practices that have a negative influence on climate change and other harmful practices in the scientific world.	The life-cycle of products from industries should be in such a way that sustainability is preserved, and learners should be encouarged to be proactivie in such matters.	No comment made.
26	No comment made.	I require them to design simple circuits so they can be aware of how electricity works.	On static electicity we talk about lightning and safety, in life and living we talk about obesity, HIV, etc.	They must know and value plants, water, for their absence is life threatening.	Action plans train them to be reposnsible citizens.	No comment made.
27	Group work creates a free, confident learning capability. Learners who are reluctant to study get motivated through sharing and debate.	Plant and animal cell, respiratory/ digestive system, using a lemmon as a battery.	Help learners of their environmental awareness and respect.	Learners should be encouraged to be critical thinkers and see beyond things.	To stimulate awareness and benefits of recycling.	Protect, respect, questions and answers, presentations (to build self-confidence).
28	No comment made.	No comment made.	We often use videos taken from varius sources to clarify complex phenomena, eg. Earth and beyond to mention but a few.	No comment made.	No comment made.	Role play, eg. When discussing attitudes and feelings towards certain phenomena in science and culture/ religion, its best when learners conduct a setting in which one group assumes the role of the authority and the other that of civil society/ ordinary citizens.
29	The formal debates develop learners' critical thinking and its not easy for them to forget the concept because the solution to the problem was acquired through formal debates.	The prjects enable the learners to develop into smaller scientists which will develop their motor skills.	When you mention social issues it makes learners aware that NS is applicable in everyday life situations which they were not aware before.	This helps learners to develop respect for NS and enable them to respet the nature as well.	Learners will learn to respect the environment and will know that the nature has to be preserved for the future generation.	I normally ask pre-knowledge questions to determine how much they understand the concept.
30	Some units require learners to be active and analytical so in the unit like planet and animal cell, I divide them into groups to discuss the differences and functions.	Last term my learners created the respiratory system using recyclable materials.	I make sure that they relate and be able to understand NS when having fun.	Some learners have values that opose NS but I encourage them to understand how science works so they can develop good values.	With such thing a learner can be creative and they come to school to learn and come up with innovative ways to improve the school and surroundings.	When it comes to units that are hard to deliver I let the leraners do peer-education by making them do a jigsaw method and followed by questions and answers.
31	Teacher centred approach	Learners are assessed with projects at the end of the term.	Formulating/ recording/ singing songs.	To create skillful/ talented learners in science.	To take care of our environment.	Teacher centred approach.
32	Debates are for that. They learn fromo each other.	Technology and science practical experiments do have the same outcome/results in learners.	Reality is the best teacher/ educator.	Science learners will be part of South African life. They will have to be integrated and be part of society.	Taking care of the environment to improve life is key.	Practical experiments. Has a lot of components and reveals learners weakness and areas they improve on, ie. Learners with colour blindness can not be pilots/ doctors etc science careers.

QUESTION 3 Basic Analysis

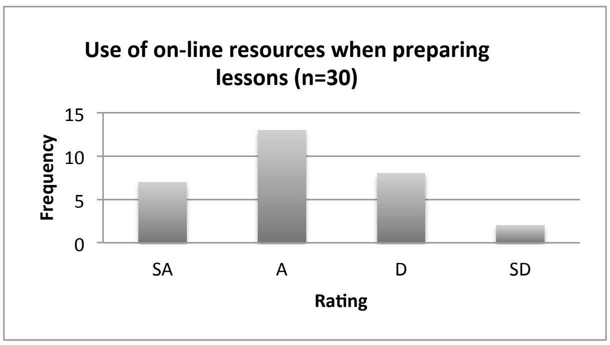
3.1 Follow CAPS?		%
SA	11	34,4
A	20	62,5
D	1	3,1
SD	0	0,0
nr	0	0,0
T	32	100



3.3 Rely on textbooks?		%
SA	3	9,4
A	18	56,3
D	7	21,9
SD	4	12,5
nr	0	0,0
T	32	100



3.5 Use on-line resources?		%
SA	7	21,9
A	13	40,6
D	8	25,0
SD	2	6,3
nr	2	6,3
T	32	100

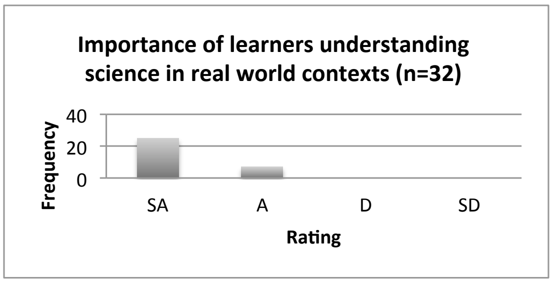


P	3.2	3.4	3.6	3.7
1	Staying up to date with work and making sure that I cover everything.	Colleagues' input is also important, TV, newspapers about the energy crisis, cartoons from google.	Telkom, for example, has study outlines for question papers.	No comment made.
2	We use Doc Scientia books. They already checked the CAPS, so I don't have to.	We use Doc Scientia books.	Not enough time. Not for Grade 9.	No comment made.
3	No comment made.	No comment made.	The use of power points (images from the internet), interpreting articles about recent research that's on their level (eg. IFL Science, Curiosity app), videos (TED-ED, a winner!, and at times TED talks: ASAP Science and Minute Physics).	Incorporate articles from "Very Interesting" (formally "Braintaiment") or "How It Works" into lessons. Posts on Instagram from Biology Minds, Medical Talks, Bad-Science-Jokes etc. encourage learners to follow interesting organisations.
4	No comment made.	No comment made.	Have access to moodle and train your brain server with many resources. Our textbook also provides web addresses of the topics.	Other teachers' teaching styles, knowledge and resources.
5	No comment made.	No comment made.	Recent information if available on-line.	No comment made.
6	Relatively young teacher - rely on books to plan lessons.	Also do more research to expand my explanations.	Interesting to see how the broader teaching community teach.	No comment made.
7	The guidelines are followed as closely as possible as is relevant to the urban learners. The lesson plans also occur around the textbook we use.	Platinum from Maskew Miller Longman. We use the textbook as a guideline for CAPS content, for activities, but also develop our own worksheets and use internet sources.	I use the internet as a source of photographs, YouTube videos and demonstrations. From the internet photos I then develop powerpoint presentations.	Learners' academic level and ability is important. Some learners prefer to keep to the basics, others are prepared to discuss and bring issues into the lesson.
8	Due to having to prepare for the possibility of a national, external exam, we need to teach to the document.	Platinum.	Time is a factor. Insufficient time for planning.	No comment made.
9	We have a textbook from the LTSM list that is followed strictly.	Platinum. We substitute the textbook with extra notes to enhance concepts.	Time is a main concern. I have done it so many years so I use prior knowledge more.	I try to prepare students for Grade 10 - 12 and often will add more information on some topics. Unfortunately this slows one down.
10	I follow the guidelines which the DoE has set for us. They check if we are doing it right.	I use the textbooks that have been approved by the DoE, but also use other interesting information I can find.	I search the web for questions and information that I find interesting and relates to certain subjects.	No comment made.
11	Because we must apply time management and can't deviate - we won't be able to finish the syllabus work and then the learners don't have reg necessary fundamentals for the next year.	I use different textbooks and other articles (published), also the internet for recent research done on a topic.	It shows latest research etc.	Newspaper articles - especially for global warming, mines (acid water), rhino poaching etc. are excellent to demonstrate Science in everyday life.
12	Forced to do this, as they are writing common exam papers. But, I definitely teach extra content as the children want to know more.	I combine all of them, as well as other book (library). I am not fond of the internet.	I am 52 years old and am very uncomfortable with technology. I show most of the content, as far as possible, practically.	I listen to the radio, especially RSG which has lots of interesting programs like "Hoe verklaar jy dit?" and the news. I watch National Geographic. I make animal cells using jelly in a plastic bag (which is the cell membrane). I will put this in plastic containers (representing the cell wall), stick them on top of each other to show a plant does not need a skeleton.
13	GDE policy.	Also use the internet.	Powerpoints and YouTube videos.	News related articles.
14	I use it as an outline. We cover all the work but try and add in and perfect skills such as scientific research, graphs etc.	Use a wide variety of materials. Textbooks, internet, scientific articles, textbooks for other grades.	Regularly use internet for videos to ad interest to lessons. Also use the internet to get different diagrams and ideas which will stimulate learners to think and explore.	Often go to what the Grade 10 - 12 learners are expected to know and then take that to Grade 9 level, especially with skills such as data response, hypotheses etc.
15	I believe it important to ensure the curriculum foundations are in place, especially for learners who intend taking Life Sciences in Grade 10 - 12.	Textbooks, scientific journals, internet, documentaries, YouTube clips etc. Via Africa. I make my own slide shows in accordance with CAPS.	Internet has a wealth of knowledge, and it is important in cross-checking references.	Attempt practicals where appropriate/ possible even if just as a teacher-led demonstration.
16	The learners write the national papers which address the CAPS document. If not followed, the learners will be disadvantaged during the exams.	Book: Via Afrika. For lesson planning and a variety of tasks it is best to use more than one textbook. This gives the learners a broader understanding of different concepts. I also create powerpoint presentations.	The other teachers also put their slide-shows on-line. This helps to have a broader way of presenting different topics.	Practical demonstrations for informal assessment. The learners do own for formal assessment. The simulations on the internet also help if one is short of physical apparatus.

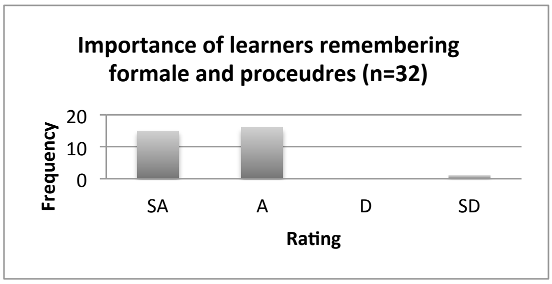
18	No comment made.	Textbooks are designed around the outcome expectations. Via Afrika.	I have built of a large resource base in my teaching years.	Newspaper articles and current events and programs on TV.
19	This informs formative and summative assessments. Instructional practices should reflect the principle of inclusivity.	Lesson plabs are informed by CAPS documents and consolidated by textbooks and other resources.	Simualtions, videos, power-point presentations	Feedback from students, Siyavula workbook and other resources from Maths-Science-Technology training, contexts and authentcity
20	We are provided with a government policy guidelines book (CAPS document).	I use different textbooks, Platinum, Via Afrika etc.	No proper resources.	No comment made.
21	Using guidelines in the Gr 9 NS CAPS makes my work easier. There are some bullets that are related to the topic that I'm supposed to teach.	The textbook must relate with my guidelines in the Gr 9 work.	To add some of the important information.	Working as a group of teachers it helps a lot.
22	I make it a point to teach each bullet in the CAPS document.	Textbooks is my only resource because technologically I am a bit behind times.	I need assistance to open on to do research from my family or colleagues.	My daily experinece influences my planning. It is easy to move from known to unknown.
23	No comment made.	No comment made.	No comment made.	No comment made.
24	I use CAPS in planning my lessons.	I rely on different textbooks during lesson, Spot On, Sasol and Platinum.	I make use of internet to get more information.	No comment made.
25	As a teacher I use Gr 9 CAPS as a guideline only, and not as a rule.	The textbook I use as a guide only, while often materials are used as visual aids.	This is for visual aids mostly.	No comment made.
26	CAPS document guidelines on specific information and scientific terms that I must teach in each lesson.	I rely on CAPS document, learners use textbook for reference. There is no textbook with all the information needed. The textbooks prescribed in my school are Platinum and Sasol textbooks provided by the department.	I do not have access to internet at school. I use online resources sometimes.	No comment made.
27	Guidelines which are science-related can make lesson planninf very easy.	No comment made.	Resources unfolds and makes understanding of lessons, projects etc easy.	No comment made.
28	Following CAPS and ATP guide places one on par with what, when and how to prepare for the coming lesson, so as to engage learners accordingly and to gather relevant teaching and learning aids.	The use of visual aids and audio cannot be left behind. I prefer the use of IT (smartboard) and projector to stimulate learning.	Most often I strive to use on-line resources but given the financial background of our learners, it delays progress and I rely on availability of data to log on to the internet, or free wifi which comes and goes due to heavy use by greater society.	Refer to 3.4.
29	This is the policy that all educators should follow the guidelines because assessment of learners is extracted from the guidelines and it helps the educators to adhere to what is stipulated in the guidelines.	The ATP will inform me and also the work schedule thereafter I will use the textbook as a resource.	I am not good in computer and therefore I don't make use of on-line resources.	There are ready-made planning from Sci-Bono which makes it easy for teachers to follow.
30	Going to class without a plan results to an unsuccessful lesson, so guidelines are good tools to make sure that I have the best lesson.	I use other resources like using posters and also videos to present my lessons.	On-line resources are always helpful, they provide extra content.	Coiming to class well prepared is my number one priority. I have to make sure I give my learners the best lesson ever.
31	At the end learners are needed to achieve aims.	Certain books are recommended for CAPS documents.	To get a good assessment because science is upgrading.	Any relevant source eg. Newspapers.
32	They are crafted to societal needs and future needs of the country.	There are other sources with current information.	On-line doesn't know your real situations on the ground ie resources, type of learners etc.	I make use of previous plans and improve on them.

QUESTION 4 Basic Analysis

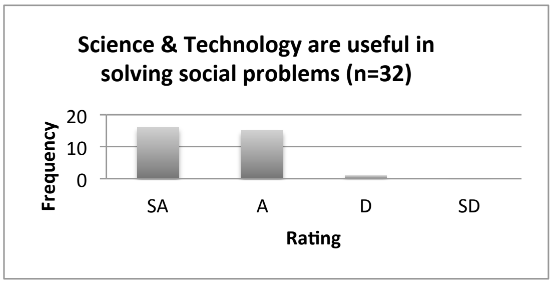
4.1		
NB L udnerst Sc in real w?		%
SA	25	78,1
A	7	21,9
D	0	0,0
SD	0	0,0
nr	0	0,0
T	32	100



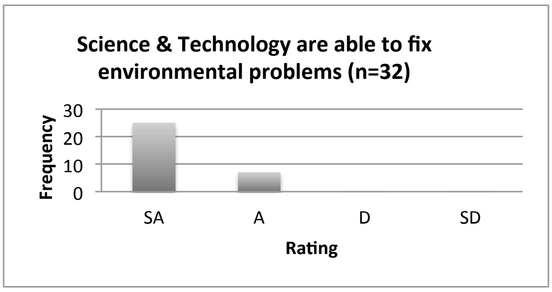
4.2		
NB L to rem form & proc?		%
SA	15	46,9
A	16	50,0
D	0	0,0
SD	1	3,1
nr	0	0,0
T	32	100



4.3		
S&T usdeul for social prob?		%
SA	16	50,0
A	15	46,9
D	1	3,1
SD	0	0,0
nr	0	0,0
T	32	100

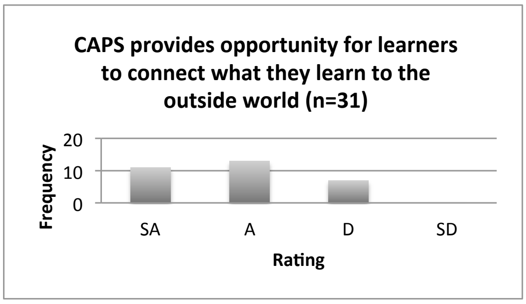


4.4		
S&T fix enviro prob?		%
SA	17	53,1
A	15	46,9
D	0	0,0
SD	0	0,0
nr	0	0,0
T	32	100



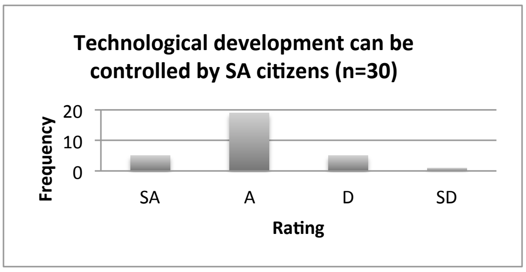
4.5

CAPS connects to outside?		%
SA	11	34,4
A	13	40,6
D	7	21,9
SD	0	0,0
nr	1	3,1
T	32	100



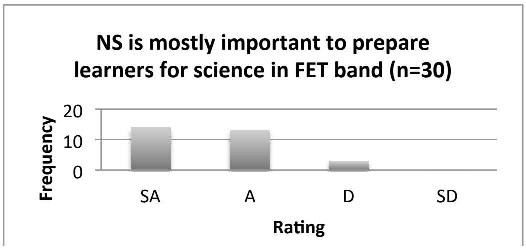
4.6

Tech cont by SA citizens?		%
SA	5	15,6
A	19	59,4
D	5	15,6
SD	1	3,1
nr	2	6,3
T	32	100



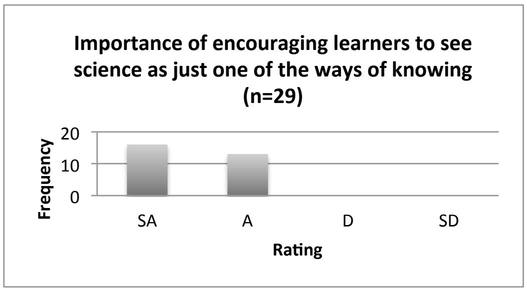
4.7

NS NB for FET?		%
SA	14	43,8
A	13	40,6
D	3	9,4
SD	0	0,0
nr	2	6,3
T	32	100

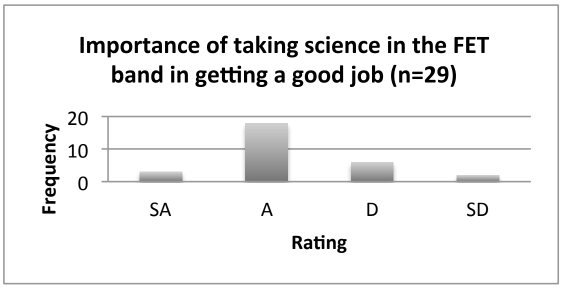


4.8

Sci just one way of know?		%
SA	16	50,0
A	13	40,6
D	0	0,0
SD	0	0,0
nr	3	9,4
T	32	100

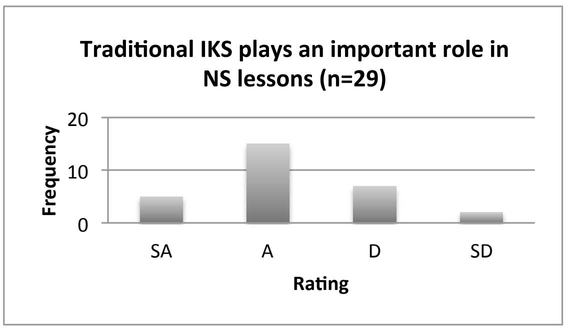


FET PS = good job?		%
SA	3	9,4
A	18	56,3
D	6	18,8
SD	2	6,3
nr	3	9,4
T	32	100



4.11

Trad IKS important?		%
SA	5	15,6
A	15	46,9
D	7	21,9
SD	2	6,3
nr	3	9,4
T	32	100



P	4.9	4.12	4.13
1	It is a diverse subject. The learners learn about everything in nature, animals, plants, nutrition and humans.	Eg. knowledge of plants for medical science and alternative sources of energy.	No comment made.
2	No comment made.	No comment made.	No comment made.
3	"Magic is everywhere if you don't understand Science". Science provides an explanation for why things happen or how did they end up this way.	To some extent. This shows that there is more than one way to approach a problem and as South Africans we can take initiative in problem solving.	The Grade 9 syllabus is so full that there isn't much time to spend on societal issues, although as an educator, would love to incorporate it to a greater extent. At this stage Specific Aim 3 is often addressed in a verbal format (debates, discussions, telling learners about it), but not in terms of creating creators and innovators. Learners are consumers and encouraging them to be content creators or problem-solvers can be a teeth-pulling process at times. A simple example: Very often I will tell a learner to take out their tablet or phone and research the question they just asked me. Approximately 60% of the time the learner will respond with "I don't have data" while there is an internal school network with a resource portal and freely obtainable apps on it.
4	We live in this world and experience everything every day. It is in front of them and take notice of it and how it affects them.	Traditional African Knowledge is only a small part of Science, which is a global subject with the same views all around the world. Learners need to know all world knowledge of Science.	We focus too much on content and not enough on the skills at junior level (primary school). When they get to high school it is too late to change their views. We can only add to it. Skills are lacking, therefore local knowledge fails and they become uninterested in the world of Science as they feel it gets hard.
5	There are other subjects the learners can take to understand the world around them, such as HSS.	No comment made.	No comment made.
6	Must be correlated with other subjects e.g.. Geography to give a better understanding of how all areas of study connect.	No comment made.	No comment made.
7	It is a prerequisite to further tertiary studies and employment after school.	Many modern technologies developed from Traditional African Indigenous Knowledge. It could be part of the history of science.	I would like to see more time in the syllabus given to Science and Society, including African. This will make learning science more relevant to the learners and will possibly encourage more discussion about South African problems and how they could be addressed.
8	No comment made.	We don't ever refer to Traditional African Indigenous Knowledge. Generally science has a very western bias.	No comment made.
9	Integration of subjects is important and students should realize the link between them. As soon as they realize this they do better.	Science is a fact based subject that has developed over many centuries. I am sure you can integrate Indigenous Knowledge, but time is restricting us.	Unfortunately the view out there is that Science is difficult and only clever people can do it. As soon as people realize that that is not true, but it depends on the amount of effort that you put in, the more it becomes a subject which is more accessible to all.
10	No comment made.	No comment made.	No comment made.
11	Everything on earth revolves around Science!	No comment made.	No comment made.
12	Science is life and life is everything, God gave us life, and He commanded us to live and control it!	No comment made.	No comment made.
13	Too big a jump from Grade 9 NS to FET band. Prepared for Life Sciences but not for Physical Sciences.	CAPS document does not have this. Educators have to adapt syllabus to relate to African Indigenous Knowledge.	Specific Aim 3 is not studied enough and does not relate to South Africa enough.
14	No comment made.	It plays a role but not a major one.	As far as possible we discuss in class and encourage learners to give their view points. Often learners do not have the maturity or knowledge to discuss the above issues without a large amount of guidance and input from the teacher.

15	Science explains the world around us, it doesn't dictate how we feel about it. That is influenced by things like spirituality etc. Home-based upbringing also plays a major role. Our more scientifically open learners come from better structured homes and are academically more inclined to achieve.	All Science has been informed by basic Indigenous Knowledge along the line somewhere. This is our land and our resources; our ancestors used it to survive, so it holds a lot of potential.	Society had given Science a stigma of "boring" and "too difficult" so learners stop trying before they start. The general performance of Grade 8s and 9s is poor as a result because they start the subject with a negative mind-set. Personally I feel that South African schools should be structured in three parts, not two (primary and high). We need focussed primary (Gr 1-6), middle (Gr 7-9) and high (Gr 10 -12). This will help the middle school educators to advance Science levels in a more appropriate way. The ump from Grade 7 to Grade 8 is too drastic because Grade 7 is taught within the drawn out primary environment and Grade 8 and 9 are too manic within the high school environment. We need a happy medium.
16	Learners need to understand how Science is used in the real world because this makes them love the subject and understand the content better.	Grade 9 learners don't know how their subject links to future careers. We at our school have a career morning for Grade 9s in order to have a positive choice of subjects.	There is no link between Traditional African Knowledge in South African science education. Only two topics tried to be, on fermentation and traditional beer was mentioned. Also in Energy and Change for lightning, they only talk about how people protect themselves from being stuck by lightning in other areas such as in Limpopo. No mention of any African Indigenous Knowledge in any chapter.
17	Science helps learners to link theory and concepts to the natural world. If they can understand the concepts they can apply their knowledge to the real world. For example, some scientists developed a plant that can provide oxygen to people in space and learners found that this plant stores solar energy. I am aware of the fact though, that Science is not the only subject that teaches us about the natural world.	Traditional African Knowledge is important because it is still Science knowledge; the only difference is that it relies more on nature, which is perfect as it offers eco-friendly products or solutions to problems which can be solved using the environment instead of abusing the environment. I believe that it is important not to forget about Indigenous Knowledge as Science has stemmed from it.	It is a good strategy that has been implemented.
18	Students need to broaden their common knowledge of the world they live in.	Most of our population used knowledge gained from grandparents. Need to expand on that and encourage the cultural and indigenous aspect.	No comment made.
19	Perceptions and explanations	IKS has a long-term effect on the African child worldview. IKS has limitations within the Eurocentric view of science as much as Eurocentric view of science has limitations within an IKS framework. Medicinal value of indigenous plants.	Will always insist on students indentifying with the benefits of science in their society. How science has benefit them - in reproductive health, nutrition, energy. What has been undersirable about scientific advance/ progress/ development. Democratic values.
20	informed by religion (spiritual) and the arts are viable sources of knowledge.	No comment made.	Indigenous science should be linked with new science. The maybe we can get good medicines etc.
21	No comment made.	Yes, traditional African indigenous knowledge to help people in real life.	Heling learners to choose careers, helping learners to understand tarditional African indigenous knowledge and relate with the health care centres.
22	No comment made.	Indigenous Knowledge about preserving fish and meat. About delivering babies and groom premature ones. By the time there were no incubators.	No comment made.
23	No comment made.	No comment made.	No comment made.
24	Students should see science as their everyday lives and connect science with the environment they live in.	There are some topics in NS which connects traditional African Indigenous Knowledge with the syllabus and learners use their prior knowledge to understand.	No comment made.
25	No comment made.	No comment made.	No comment made.
26	No comment made.	No comment made.	No comment made.
27	No comment made.	There is a link between the two. Learners should know where they come from.	Visiting science-related expos.
28	No comment made.	Most students choose science and technology to help find solutions to the current problems of pollution and poverty in our country, not only for a good paying job. This they showed during their schooling years when they showed passion to solve problems of littering, water waste and late coming.	Learners should be given an oportunity to undertake excursions where real life situtaions are tackled head-on.
29	When teaching NS practicals/ experiments science is a practical subject.	No comment made.	No comment made.
30	Knowing your body functions is good. NS provides that to NS learners. Understanding yourself should be part of everyday activities.	Learners must know that science is also available in Traditional African Knowledge, for example most plants can be used as medication eg aloe plant.	Society as a whole is not focussing a lot on science, people have to believe that science is difficult. Instead of understanding to influence the society. They focus more on te cons instead of the pros science can bring in our society.
31	Learners need a good foundation.	Discovering and upgrading of science give you more opportunities.	No comment made.
32	No comment made.	Alows learners to understand evolution in science ie prgressive process.	No comment made.

APPENDIX 9 Interview Transcription for Teacher 1

	An introduction and thanks were expressed to P. A brief description of the research focus was also explained.
I	Let's start with Specific Aim 3. Perhaps you would like to refresh your memory I read in this section.
	First marker shown. P reads section marked.
P	Okay, ja, I remember it.
I	So first of all some general information about you, what motivated you to become a science teacher?
P	I love science. I've always wanted to teach, and also if you teach you can travel. That's mainly the reason why it became a teacher, so that I have the opportunity to travel.
I	Excellent. Provide five adjectives to describe you as a science teacher.
P	Disciplined, there's a very strict routine in my classroom, and then, okay, spontaneous, I like to do random things, and then, very visual, that's three...this is hard...um, I think, well structured...that's all I can think of.
	I and P laugh.
I	Okay, and the next questions are about your views on science education but also in light of what's the curriculum document says. Over here they have given as guidelines about teaching natural sciences, if you wouldn't mind just refreshing memory and reading the following passage.
	Second marker shown. P reads section marked.
P	Okay.
I	Okay so in light of those ideas and also your experience as a science teacher and as a scientist as well, what do you feel the current goals of NS education are?
P	Natural sciences provides really a very basic understanding of a variety of larger scientific concepts in preparation of further studies in the FET band, but in general I don't feel that it does a very good job of that. I feel that they are trying to squeeze in so much knowledge and content into such small spaces of time end and then you end up rushing through it. For example, now, the Grade 9s doing chemistry, where in Grade 8 you did the structure of the atom and all of that...now when I ask my kids, what is atomic mass, what is atomic number, then they don't know because last year we rushed and now there's just this compounding effect of just rushing, rushing, rushing, and they never really fully understand what they are supposed to do. **They also just cram it in to get it in for a test or exam**. So by the time I get to again in this year you have to spend a whole lesson reminding them that this is the atomic number, this is the periodic table, this is a group, this is a period, that's how you draw an atom. So I feel that if they just removed some of the content and just spaced it out a little bit more and actually gave us time to do things. For example in the first term when we do all the systems, all the human body systems, this is the third year that I've taught it and I've never ever been able to finish all the body systems, because there is actually so much information that you can give them, and if the child doesn't continue on with FET Life Sciences they will never know anything about the body. So there's just really not enough time to give them a General understanding of how all of that stuff works.
I	Okay and then related to that what do you see your primary role as being in the NS classroom?
P	Mainly just to get them interested, because realistically not many of them are interested in science, and then later on when they need to choose subjects they ask you what's the difference between Physical Science and Life Science...so you will get kids that are only interested in a specific topic, and then when they realize this topic is only a small part then they decide not to take the subject. I think that mainly my role as an educator is more just to show them how interesting things actually are and inspire them to do a little bit of delving themselves.
I	Okay and then the third point relating to that, do you think that the curriculum statement provides opportunities for relevancy to the students lives, do you think it piques their interest?
P	No.
	I and P laugh.

P	Um, say for example, I am teaching Grade 9 NS, in terms of just taking Chemistry and making it relevant to them, literally through the entire term, the whole chapter for this term, there is very, very little, there's a lot of theory and very little that's actually relates it to real life. So an example that I used the other day, we are not even at acid-base neutralization reactions yet, I was just basically trying to just give the idea which will be coming on later, so they don't fell too uncomfortable, but what I did do is just mention where you have bicarbonate, which is a base, because we are dealing with naming compounds, and you use it in baking, so if you take bicarbonate, and then you show in acetic acid, which is vinegar, together, then what do you get? And they are all like...uhhhhh...
	I and P laugh.
P	So like if you're baking flapjacks and you throw in bicarbonate and you throw in vinegar, and then you didn't stand for a little bit and then what happens to the dough...you get bubbles and those bubbles are carbon dioxide. Just to try make them realize, that wait, when I put these two substances together it creates something else, and you can physically see that, but I as a teacher had to apply their example myself, it didn't come from the curriculum document. They also do the tests for oxygen, and stuff like that, but they don't have any...like we're in real life you actually use it. So although that's practical it's still not relevant.
I	Thank you. So the next couple of questions related to your ideas on the Nature of Science, also based on the curriculum document. Over here they've given us the preamble about what is science.
	Third marker shown. *P reads section marked.*
I	What is your feeling about that statement?
P	In terms of scientific knowledge that we teach now, it's like playing catch up, because you're not teaching them anything that is close to being new, any time soon. I also think that that's why it's so difficult to relate to real life what you're actually teaching, because there is this big gap in between, between what's relevant today. We Teach most of the stuff this fact anyway, but silly things like the orbitals of an atom, it's not really a circle around it, so you try and tell them it's the space where an electron is most likely to be found, but that's mind blowing for them. I've shown them a little drawing of the possible orbital shapes, what it actually does look like, and then they're just like...uhhhhh...no.
	I and P laugh.
P	I think in terms of teaching the kids these basic steps is important and catching up all this ancient knowledge, but somewhere in between it's still just catching up, and then in University you're expected to just bridge this gap with stuff that nobody ever told you.
I	Thank you. Okay then just to touch on indigenous knowledge systems. I just want to refer to it in the preambles.
	Fourth marker shown. *P reads section marked.*
I	What is your feeling on indigenous knowledge systems and how do you use it in the classroom?
P	The only indigenous knowledge that I would be able to convey in a lesson is in terms of the Afrikaans culture, some things that my gran tells me, medicinal concoctions that she would come up with. Other than that I don't really, I've never actually taken the time to research it. You'll find that in the old textbooks they do actually have, I think it was when it was a OBE, Outcomes Based Education, the textbooks had more passages on indigenous knowledge, like a little reading sections and examples, where here it's very theory based, theory based, and every now and then there will be random sentence, and then the kids ask you and it's just like...uhhhhh...well...
	I and P laugh.
P	It's never even been a thing that the majority of what we learn in science was discovered by white males, the kids are very westernized. I have tried to mention this basically in terms of where are you in the societal structures, that's kind of where it came from, where more knowledge was recognized from males, white males, but what I do try and emphasize is that we need more female scientists. I always try and encourage my girls to continue with science. I try and emphasize, that you are the change, and you need to do something about it.
I	Alright, and then, this is part of my research methodology, here is a table showing some teaching strategies from theorist that I'm using. The strategies relate to teaching science in society. Please spend a few moments reading through the table, and then choose three strategies which are very typical of you teaching approach and then three which do not feature at all in your classroom.
	STSE currents *P reads table and asks for clarification on definition of SSIs. I responds with an explanation.*

P	Okay a lot of this case studies involving SSIs, moral and philosophical, and then also your value clarification and decision-making. The ones I don't use, designing and building artifacts, um, also historical case studies...then...I actually do use a lot of these things, but alternative knowledge systems I don't really use that.
I	Excellent. Thank you. Just to finish off, the question is please speak about your interests in science and society in South Africa, in how use this in your lessons or school activities. Here I would also love to hear more about your Environmental Club.
P	They are these talks called 'science and cocktails'. It's every last Tuesday of the month at 'The Orbit' in Braamfontein. They have really interesting science talks. I mention to my classes, especially when there are relevant topics to our content. I like to attend little talks like these. In terms of my class I don't really organize any activities, there is no environmental club at my school, but I have taken my kids on outings. There was an excursion now for the seniors, after they did the biodiversity of animals, we took them to the Natural History Museum, and then to the zoo. Generally what I doing class when they ask a question, then I'll get them to take out their tablets and research it themselves. Generally I just try and get them to interact more with science things. What I have done before is that in a term they have to bring one article, anything... But they know they are not allowed to use Wikipedia as a reference or a 'You' magazine. The seniors are better at it, most of the time the kids are reluctant to use the data.

APPENDIX 10 Interview Transcription for Teacher 2

	An introduction and thanks were expressed to P. A brief description of the research focus was also explained.
I	Let's start with Specific Aim 3. Perhaps you would like to refresh your memory I read in this section.
	First marker shown. P reads section marked.
P	Thank you, needed that reminder.
I	So first of all some general information about you, what motivated you to become a science teacher?
P	I've always liked biology, the natural sciences, it was my strong suit at school, and then when I was at University we had learning methodologies and we could choose which ones we went to. I went to the Natural Sciences one. The lecturer who presented the course was very inspirational. Her focus was working in underprivileged schools and so she gave us an unusual twist on the usual content. I enjoyed the different perspective. Also how to get kids engaged in the natural environment and also develop a responsibility as a person in society to become an asset. So it was an accident that I landed up there, because the actual scope of my degree was teaching but also psychology. At that stage I was more interested in psychology aspect but when I did my internship at this school they urgently needed an NS teacher , and so I stayed on teaching NS because I enjoyed the subject so much. Actually one I've noticed with the curriculum is that if a person has an interest in the environment then that's what they will focus on and they will link every other section to that, but otherwise I think it gets neglected.
I	Excellent. Provide five adjectives to describe you as a science teacher.
P	Very stern, especially in the lower grades. I would say a little bit eccentric, like seriousness and then merging that was humour, a bit of entertainment because you have to be a bit of a performing monkey in order to capture kids' attention because a lot of them are not aware of natural phenomena, there's no interest necessarily because there is the social media, the cellphone, television, the games, so live kids don't have their appreciation for looking at a leaf and asking why it's facing the sun. Creative, in being able to link the different areas for them as well because a lot of kids think in a very narrow-minded way because of perceptions in the textbooks. They don't realize that everything in nature is interlinked. Consistent, where like they do graph skills and you have to consistently hammer in those skills and the practice of the skills. That level of consistency is definitely necessary. Passionate, ja, I love my subject. It's the best subject. I love relating real living into scenarios in the class, and also because I have a fondness for God, that I can link aspects of my character into what I teach.
I	Thank you! Okay, and the next questions are about your views on science education but also in light of what's the curriculum document says. Over here they have given as guidelines about teaching natural sciences, if you wouldn't mind just refreshing memory and reading the following passage. Start there and end there.
	Second marker shown. P reads section marked.
P	Okay.
I	Okay so in light of those ideas in the document, and also your experience as a science teacher and as a scientist as well, what do you feel the current goals of NS education are?
P	Um, well, I agree with a lot of these things like to develop that discipline, that they need to have, because it's a science you have to have that discipline, especially in your hypothesis testing. I liked the fact that they pay attention to this but I do find a lot of the textbooks, don't develop this skill, even the ones based on CAPS. We use the "Explore" textbook that SASOL printed. For me, what I do, I supplement the lacking textbooks with different tasks and assessments, especially the stuff needed for further studies in higher grades. I think reading this, I can see that the textbooks failed to meet the curriculum's needs. I still feel, I find the grade 8 and 9 textbooks don't focus on all areas equally well, if they're good in one area they to be bad in another. The content always seems to dumbed down. So that's why I feel maybe it's not the curriculum that's failing, but the textbooks that are supplied. Back, for example, I made an experiment to see the effects of acid rain on germinating seeds. They do it over a period of two weeks with different concentrations. This incorporates aspects of environment studies but also hypothesis testing. But I had to think of the idea myself because it's not in the curriculum document. That sort of thing gets them curious about things and then they've got do research on certain towns that have all these problems with acid rain. The history of science and the relationship of natural sciences to other subjects is also very poorly touched on in textbooks. Very poorly touched on. I studied the OBE system at University and this list of goals is very similar to the OBE system and the outcomes in that system so this is what I

	know and this is how I teach. If the curriculum is interpreted right, I do think that it will develop scientifically literate students. I've learned to integrate it more and focus on it more. A lot of people I know don't even read the section or move towards it at all, and I think that includes the people who made the textbooks, because I don't think the textbooks are geared towards these aspects, and it's incredibly important for learning, and not just learning as an individual, but learning to become a solution to a problem for the future. Natural Sciences definitely should develop critical thinking, the subject forces you to extend your view from just yourself to other things in the environment. It makes a more aware public, if we develop the right mentality. Uh, I think that this stuff is not fully expressed in the schedule, and I understand, because of time constraints, getting all the experiments done.
I	Okay and then the third point relating to that, do you think that the curriculum statement provides opportunities for relevancy to the students lives, do you think it piques their interest?
P	Certain topics kids, would naturally be interested in, like the human body, there's always that definite interest, um, but ja, I suppose there's enough for there to be sufficient amount of interest, there's enough interesting things to be seen here, but also like when you're dealing with the reactions of the carbonates four example, being broken down by acids, all those chemical reactions in the physical section, what should happen, but it only comes again in grade 10 if you take the life sciences is where they talk about how the acid rain is affecting the carbonates on the rocks, and, and, you have to wait until grade 10, and it's not everyone that getting that, so, I do, if you juts have this and you don't teach 8 to 12, you, you tend to, leave bits of information in isolation, and there's no integration of the information then.
I	Okay that's interesting.
P	But otherwise I think they would be sufficient amount of interest drawn.
I	How much of drawing out the interesting information relies on you as the teacher? To make it interesting?
P	Um, I would say that there's a good proportion, I would say that there's 50% of interest drawn by the teacher, uh, and I know for myself, I always respond to someone who lectures, who brings the content to life, but I would say that the content is interesting so that's why I say 50%, the content that is here allows them sufficient information to be able to decide if they want to take Life Sciences or Physical Sciences further to 10, 11, and 12, and then hopefully the careers will move in that direction.
I	Okay, so, and then the last part of this section, and then related to that, what do you see your primary role as being in the NS classroom?
P	To connect the dots, to, to, teach it holistically, from a holistic point of view, and also to teach the disciplines of science, because a lot of people Believe that because it's science it means it's fact, uh, so my role is to teach them critical thinking, give them the tools to be able to ascertain, like, there's a theory, we were talking about it, um, the, in the grade 10s, the one is the theory of how phloem transports the glucose from the top of the trees to the bottom of the trees, so then I said 'guys here's the, this is the difference between theory, it's someone's, it's what they've discovered, and what holds truth for the time, and it will be true until they can find any kind of data that fills it up later, so does that mean that scientific fact? What is the definition of scientific facts? It means it can be tested and you'll get the same observable results'. So I say 'that's a theory, so don't assume that because it's a theory, it's fact, it has to become an axiom', and then I teach them that axiom, because axiom is the term that they use in university, so you, you just start creating that ground, it's that role, to create that critical thinking, um, to be that kind of scientist that is not limited by someone else's information, the information is there but is it fact, that's the question, because a lot of people go through life believing that what they've learnt as true, but that's not necessarily true, and then that also creates limited thinking, and then we don't solve problems, we create more problems, we create sheep or lemmings, whatever you want to call it...
	I and P laugh.
P	And, uh, where the world is going towards, you can't be that kind of person, you can't blend into the crowd, and be like everybody else, you have to be the person that stands out. So that's the one role, and the other role is also to integrate um, the person, you know, you as an individual, because science as an intelligence needs to be developed as well, and needs to be seen, that's who you are, and what can you do, you know, with your character, and how to develop that.
I	Okay, well, your students are very lucky.
	I and P laugh.
I	Okay, then, your views on the nature of science, so not science education, but science itself, um, as a discipline, the statement highlighted here...

	Third marker shown. *P reads section marked.*
I	Okay, what is your feeling about that statement?
P	It's a positive feeling, it's good, because that's what we have to do, because back in the day, people believe that the earth was flat, or, that, you know, that the earth was the centre of the universe, so, you have to show them, because then they can laugh, and see how ridiculous things are, but then also tell them, that's reality, that's how things are, people were killed because they believed that the earth was round, or whatever, and of the difficult struggle that scientists like Galileo, um, and uh, I can't think of anyone else, what they had to face to, to, to break down those expectations, also like way the religious things come into play as well, because of how science was seen in terms of religion, so yes, we do talk about that, and then it's also important because then for example, a lot of solutions were found because someone wasn't agreeing with the, how things were being done, um, and they also need to know that life is not easy, and the information that we've got now didn't just happened all of a sudden, this was actually peoples hard, life struggle, and they didn't have the technology that we have today, and this is what they got, so maybe you need to consider what are you doing with your life, because you're playing on your phone, you're texting on Instagram, or sending photos, and you on Facebook, how is that improving the world? So, I do Think that kids need to discuss things, and develop their own ideas of things, like when we deal with cloning, and I say 'okay these are some of the things that it's about, but these are the benefits', then they argue amongst themselves, are you for it or are you against it? Even controversial things like abortion, that also needs to be touched on, because, if, if like I feel a lot of things that happen there are bad because people aren't allowed to develop their own ideas, and their opinions on things.
I	Yes, thank you, okay then, um, just to touch on your views on indigenous knowledge systems, okay so over here, if you would just read....
	Fourth marker shown. *P reads section marked.*
I	Okay, so what are your views on teaching using indigenous knowledge, do you use it? Do you think it is relevant?
P	Ja, ja, very relevant, um, how do I put it, um, I believe, that each generation from the beginning, each one of us discovers a gem, and develops the gem, uh, how do I put it, and each generation before is the giant's shoulders that the next generation needs to stand on in order for us to reach our full potential, because I don't believe we as human beings are reaching our full potential, um, so indigenous knowledge systems I think is good, and I do integrate it, because I often tell them 'okay, this is a way of doing things, this is how the Greeks looked at it, um, and how did they solve problems? It's because they asked questions about things, what do we do? We use hypothesis testing, we have a phenomenon, and then you have to ask yourself how does this happen? The you always write the investigation question', um, for example. I was fortunate enough, when we did botany at University, we did a lot of the indigenous plants, for example, um, and at that stage they were busy doing research on the cancer bush, and the, um, devil's claw, and then I integrate that, and also talk to them about how now we've got this plant that can cure so many things, but look what's happening if you were to exploit that resource, so, what can we do to prevent that from being exploited? Also when we do earth and beyond in grade 9, unfortunately again it's not in the textbook, but I love stars, there's a lot of stories about stars and I have a few presentations, to talk about those kind of myths that were written into the stars, why did people associate so many stories with the stars? Because back in the day that's how people spoke and that's how they related knowledge, so yes, I like to integrate it, because everyone contributes to each other. I think that Western science dominates too much. It's that proverbial big dog that's got more clout, so because the western societies have always claimed to develop themselves more, trying to find new knowledge, trying to get better, where as your other systems, your African systems, your Indian systems as well, because they also have their things, but the west because they have more tools they are the louder ones, and other cultures, the way they do things is just very different to the western culture, and the westernised people, they don't like to integrate, they want to be set apart. Where I've taught at, and I think like our area like Gauteng, we are so westernized, I feel like certain areas like Limpopo, and some areas like in Natal, those kind of people, they would feel the deficit, and that's also why they don't do so well in the CAPS curriculum, as much as the more westernised people, across different cultures.
I	Okay, then, this is part of my research methodology, using this table showing some teaching strategies from theorist that I'm using. The strategies relate to teaching science in society. Can you look through the table, and then choose three strategies which you often use and are very typical of you teaching approach and then three which you do not use at all in your classroom.
P	Okay.
	STSE currents *P reads table and asks for clarification on some definitions. I responds with an explanation.*

P	So like with the grade 8s, I had this one experiment, where they have, I give them all clear water, except for one group, I give them something, what do I give them, it's clear until you add another chemical, I can't remember what it is now, so would that count as simulation?
I	Yes, absolutely.
P	But I don't do that often, so that doesn't count.
	STSE currents *P reads table.*
P	Okay, three least, okay, uh, role play and drama, that's the least, wish we could, but no time, uh, um, community projects, and this action plans, never used that.
I	Okay.
P	What I use the most, is your moral and philosophical, values clarification, I would put those two together, they usually are interlinked, we do do debates, uh, and then, problem based learning, how I, I give them the basics and then I give them a picture of the structure of an organ on the board, or whatever, and from there they must try and apply what tissue you would find it, so I would definitely say problem based learning, and then this values clarification and decision-making, um, uh, I would say the simulations.
I	Thank you. So that's basically all, my last question is how you use science and society in your teaching, but you've spoken a lot about it already, um, so any last remarks?
P	Uh, I can't really think of anything else, what I am said about, because what I, because I have tried to push the kids towards is like, all the paper at the school, to get that recycled, and I haven't had any biters, I would have done it myself, but unfortunately my time, it's very time-consuming, time is a serious problem, there's an aspect where do you think I failed.
I	Thank you so much for your time and your comments.

APPENDIX 11 Interview Transcription for Teacher 3

	An introduction and thanks were expressed to P. A brief description of the research focus was also explained.
I	Let's start with Specific Aim 3. Perhaps you would like to refresh your memory I read in this section.
	First marker shown. P reads section marked.
P	Ja, I remember it had something to do with society, understanding the uses of science and indigenous knowledge.
I	So first of all some general information about you, what motivated you to become a science teacher?
P	I've always enjoyed the environment and I'm a lifelong learner, these two together for me very well. It kind of suits me and then I also enjoy passing that knowledge over to kids, specifically being focused on the environment, especially ecology, conservation. Before being a teacher I did do some research in the field, so I have their background. I've got a lot of background knowledge which doesn't always come across in the classroom because that opportunity is not there with the curriculum we are just too busy, but I do run the enviro-club.
I	Excellent, we will talk more about that later on in the interview. From your questionnaire I am excited to hear about that. Provide five adjectives to describe you as a science teacher.
P	Informative, knowledgeable, caring, also interested in kids experiences, what their understanding is, also hopefully fun.
	I and P laugh.
I	The next questions are about your views on science education but also in light of what's the curriculum document says. Over here they have given as guidelines about teaching natural sciences, if you wouldn't mind just refreshing memory and reading the following passage.
	Second marker shown. P reads section marked.
P	Good to read that again!
	I and P laugh.
I	Okay so in light of those ideas and also your experience as a science teacher and as a scientist as well, what do you feel the current goals of NS education are?
P	I would say that it is to help kids understand what they are relating, what they are experiencing, in their everyday lives, especially at the intermediate and senior phase, is to observe what is happening around them and in the classroom we can hopefully explain it so that they are able to understand their world better, and make better choices and better decisions.
I	Okay and then related to that what do you see your primary role as being in the NS classroom?
P	I see it as instruction but also to facilitate their understanding and their thinking processes, so that they are understanding that what they do at home has an impact on the environment and in the classroom hopefully there is some opportunity to discuss that.
I	Okay and then the third point relating to that, do you think that the curriculum statement provides opportunities for relevancy to the students lives, do you think it piques their interest?

P	I think the NS statement is very broad, and it's still very theoretical. I think there is not enough development of tasks and things, and we tend to keep to the very traditional stuff in the classroom and we haven't gone far enough to...it's a difficult one because, there are the environmental education programs which offer those practical things, where kids have hands on tasks on daily science, whereas in the classroom we don't have that, but I don't think you can do it in the class because it's sometimes too simple and it doesn't... again it's a time issue. It would be nice if we had the time to discuss everything, what the kids experience at home and the environment and society, but there's too much to cover, theory, you know, there's too much. I think that the curriculum really needs, I think in my view it could be improved, because that's one of my frustrations I don't feel that with my experience I have sufficient opportunity at school to actually get it across to those kids. We are confined by human biology, and other topics, they are not enough environmental topics. I think that because we are teaching the youth, and if we influence the youth, they as adults will be more effective. So I certainly would like to see because it's my interest that there is more environment but that it's more practical stuff. Useful stuff I don't think that there's enough useful environmental topics being done at school. We need to get across to these kids because like conserving the rhinos and the vultures, and it's not getting across to the kids. Ja, and why buying food wrapped in plastic, you know, convenient foods. The kids have not a clue and especially living in the city. The curriculum is trying to deal with people that are across the board, whereas kids in the rural environment will experience it as completely different to the kids on the towns. The curriculum doesn't make room for that.
I	Thank you. So the next couple of questions related to your ideas on the Nature of Science, also based on the curriculum document. Over here they've given us the preamble about what is science.
	Third marker shown. *P reads section marked.*
I	What is your feeling about that statement?
P	I think in the classroom tend to build on the historical development of science. So we are teaching it is likeness because other time this is theory and facts that have built to that. It's fine. I don't have an issue with that. There's a lot of new stuff coming out. We've got to be careful of bringing too much new information for minds which are not really to understand the concepts and that's also an issue with teaching science that they, for example light was taught in Grade 10 and now it's taught in Grade 8 and that's a huge conceptual difference. In the development of the curriculum that has to be taken into account.
I	Thank you. Okay then just to touch on indigenous knowledge systems. I just want to refer to it in the preambles.
	Fourth marker shown. *P reads section marked.*
I	What is your feeling on indigenous knowledge systems and how do you use it in the classroom?
P	We don't use it or other than we might refer to it here and there, but that's about it. You know, it comes down to what do you want to achieve doing a certain activity. It's fine, we can make solar cookers, and use traditional techniques and so on, but what is the function and purpose of that exercise? At the end of the day, what are we trying to do: we are trying to train kids in the scientific method and in understanding and in questioning. So yes, we can bring those things in, but it must have the basis of the scientific method, and bring in that understanding from the western side to explain the indigenous methods. That I don't have a problem with. I think the Western methodology works and it's logical and it can be applied to any situation. That doesn't really exist in the indigenous systems. So in the world that we function in it's relevant, and I think that anybody who wants to function in this predominantly western environment needs to adapt to that. I don't think that the kids have an issue with that, they don't have a problem because they can go back to the rural situations and apply using that approach to develop whatever...

I	Alright, and then, this is part of my research methodology, here is a table showing some teaching strategies from theorist that I'm using. The strategies relate to teaching science in society. Please spend a few moments reading through the table, and then choose three strategies which are very typical of you teaching approach and then three which do not feature at all in your classroom.
	STSE currents *P reads table and asks for clarification on definition of SSIs. I responds with an explanation.*
P	Okay I would go with argumentation and debates, moral and philosophical, and maybe use of SSIs. The ones I wouldn't use would be risk benefit and stakeholder analysis, role play and drama, and probably action plans in local and global contexts.
I	Excellent. Thank you. Just to finish off, the question is please speak about your interests in science and society in South Africa, in how use this in your lessons or school activities. Here I would also love to hear more about your Environmental Club.
P	In the classroom, if I can, I do I give time to issues the kids experience here in the city, say for example, the flooding of the roads when that happens, or the pollution problems and the connection to respiratory disease. So we do try and talk about those. For example I will instruct the class and talk and do the theory, and then spend some time just having a discussion one on one, what's your opinion, what is your experience, just to finish off the lesson. Out of that in the Enviro-club I focus on very much on...I think it's important that we don't go to the traditional way which was very conservation orientated, you have to go to the zoo, look at the animals, we need to conserve the animals, I think it's a lot more than that these days. So I tend to encourage my kids...we are very much involved in community environmental projects. So for example, clean-ups, alien invasive removals from the local eco-park up on the hill there, there's Albert's Farm on the other side, and the parks around here, as well as occasionally making the kids aware, we probably should do it more, but the whole around plastics and littering, and trying to bring some discussion to the school although that's more difficult because it's very peer pressure orientated. So that doesn't work as well as I'd like. But the Enviro-club has been involved in upgrading the school, in terms of its greening. So now the school uses boreholes and these motion sensor lights that only come on when someone enters a room. I also work with what the kids are interested in. Now, for example, there was a Black Eagle project that the kids were interested in. So we supported that and we got everyone involved, got the word out to the school and we sold badges. So basically I use the group, it's not a very big group, to drive projects within the school, and then if we do go on an outing we draw other kids in. You're very few schools that have environmental clubs and there are a lot of kids who are actually interested, and I really just think that that needs to be encouraged. We are one of the few government schools in the area that have an environmental club, and it's very much a private school thing, but it's so important.